# WEST 3750
# PROGRAMMER/CONTROLLER
## Installation & Operating Instructions

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THE INTERNATIONAL HAZARD SYMBOL IS INSCRIBED ADJACENT TO THE REAR CONNECTION TERMINALS. IT IS IMPORTANT TO READ THE MANUAL BEFORE INSTALLING OR COMMISSIONING THE UNIT.

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# WEST 3750 PROGRAMMER/CONTROLLER INSTALLATION AND OPERATING INSTRUCTIONS

**IM-0039-A0**

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# SECTION 1
# INTRODUCTION

The WEST 3750 is a compact "proportional plus integral plus derivative" (PID) programmer/controller. The facilities include a wide range of inputs, proportional cooling output and auto/manual operation. The options available include the capability to operate as either a slave or a master via an RS485-compatible serial communications link. The front panel is equipped with red light-emitting-diode (LED) displays.

The 3750 can control temperature (or other process variable) to a pre-determined profile. This profile may comprise up to two ramps (positive or negative gradient) and up to two dwell (soak) periods and is easily programmed into the Controller by the user. A "cycling" facility is included which enables the Controller, if desired, to repeat the profile automatically a pre-determined number of times (up to 9999) or indefinitely.

The Controller housing conforms to 1/8 DIN measurements and Controllers may be mounted conveniently side-by-side in multiple installations. Power consumption is only 5 watts approximately; therefore minimum ventilation is required.

## 1.1 OPERATOR CONTROLS AND INDICATORS

The Controller may be operated in any one of three modes: **User (Normal Display) Mode, Function Set-Up Mode,** or **Run-time Control Mode.** In User Mode, if a profile is not currently running, the operator may adjust the set point value and monitor the controller outputs; if a profile is currently running, only dwell set point adjustment is possible (if enabled). In Set-Up Mode, all profile data, control parameters and programmer functions can be reviewed and adjusted. In Run-time Control Mode, the operator may initiate, hold (suspend) or abort a profile or may jump to the next segment of a currently-running profile; the operator may also select manual control (if this is selected whilst a profile is running, the profile is automatically held and will resume operation when the Controller returns to automatic control).

The Controller front panel has a number of operator controls and indicators to serve the following functions:

**Upper display:** Normally displays the value of the process variable. In Set-Up Mode, the value of set point and other control parameter values are displayed after selection by means of the front panel pushbuttons. In Run-time Control Mode, this displays the run-time control options offered for selection.

**Lower display:** Normally displays the set point value. In Set-Up Mode, it displays a legend which identifies the profile data, control parameter or programmer function being viewed/adjusted.

**LED Indicators:** The 3750 front panel is equipped with seven LEDs which indicate the various output states and Controller functions.

**Controls:** Four pushbuttons are provided for parameter entry and for selection of Controller functions.

Full details of the use of these controls and indicators can be found in Section 3.

## 1.2 OPTIONS AND VARIANTS

There is a wide range of options and variants available for the 3750 Controller. The variants and options fitted to each controller are indicated by the product codes shown on the product code label affixed to the side of the controller. Full details of the options and variants available and guidance on interpretation of the product code label are given in Appendix B.

# SECTION 2
# INSTALLATION

## 2.1 UNPACKING PROCEDURE

1. Remove the controller from its packaging. The Controller is supplied with a mounting clamp and two screws. If a Remote Front Panel option (X74, X75 or X79) has been ordered, the package should also contain the remote front panel and the connecting cable with terminating plugs.

**NOTE**

Retain the packing for future use, should it be necessary to transport the Controller to another site or to return it to the supplier for repair.

2. Examine the delivered items to check for damage or deficiency. If any is found, notify the carrier immediately. Check that the product code shown on the product code label (affixed to the side of the controller) corresponds to the Controller ordered.

## 2.2 PANEL-MOUNTING A STANDARD CONTROLLER

### 2.2.1 Pre-Requisites

The panel on which the Controller is to be mounted must be rigid and may be up to 6.00 mm (0.25 inches) thick. The cut-out required is as shown in Figure 2-1.

Several Controllers may be mounted side-by-side in a continuous cut-out of width:

(48n - 4)mm or (1.89n - 0.16) inches

where n is the number of Controllers to be installed.

The Controller is 150mm (5.90 in) deep, measured from the rear face of the front panel. The front panel is 96.00 mm (3.80 in) high and 48.00mm (1.89 in) wide; when panel-mounted, it projects out 6.00mm (0.25 in) from the panel.

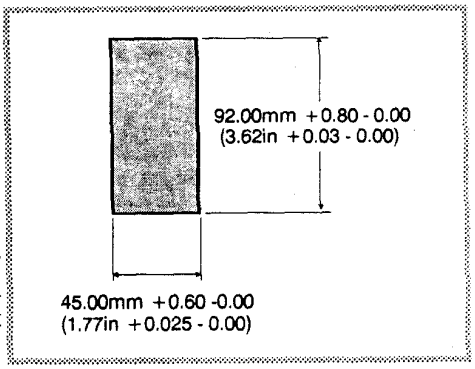



**Figure 2-1 Panel Cut-out Dimensions**

### 2.2.2 Panel-Mounting Procedure

1. Insert the rear of the Controller housing through the cut-out (from the front of the panel) and hold the Controller lightly in position against the panel.

2. Slide the mounting clamp into place on the Controller (see Figure 2-2) and push it forwards until it touches the rear face of panel. Teeth on the arms which project to the rear of the clamp will engage with the ratchets moulded into the top and bottom surfaces of the Controller housing.

3. Gently tighten the screws in the clamp till the front panel is fitted snugly in the cut-out in the mounting panel.

**CAUTION**

Do not over-tighten the screws; this will distort the mounting clamp.

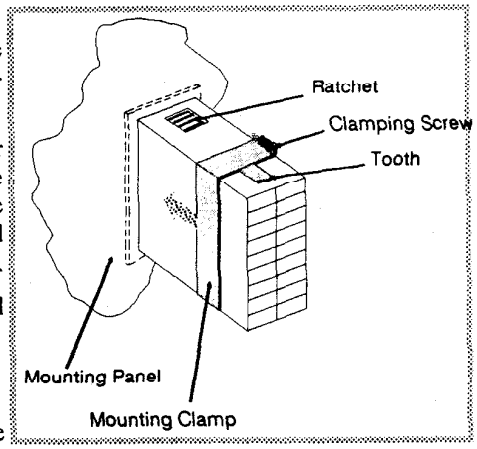



**Figure 2-2 Panel-mounting a Controller**

## 2.3 PANEL-MOUNTING A CONTROLLER WITH A REMOTE FRONT PANEL

### 2.3.1 Pre-Requisites

#### 2.3.1.1 REMOTE FRONT PANEL

The cut-out required for the remote front panel is the same as that for the standard Controller (see Figure 2-1). The remote front panel is 28.00 mm (1.10 in) deep, measured from the rear face of the front panel. It is 96.00mm (3.8 in) high, 48.00mm (1.89 in) wide and, when panel-mounted, it projects 6.00mm (0.25 in) out from the panel.

#### 2.3.1.2 CONTROLLER

The cut-out required for the Controller is the same as that for the standard Controller (see Figure 2-1).

### 2.3.2 Panel-Mounting Procedure

#### 2.3.2.1 REMOTE FRONT PANEL

1. Remove the mounting clamp from the front panel by undoing the screw which holds it in place.

2. Insert the remote front panel into the cut-out in the mounting panel.

3. Holding the front panel in position, re-attach the mounting clamp, securing the front panel in position.

#### 2.3.2.2 CONTROLLER

The Controller may be mounted in the same manner as the standard Controller (see Subsection 2.2.2 and Figure 2-2) or it may be secured with a chassis mounting bracket as described in the following procedure (see also Figure 2-3):

1. Attach the chassis mounting bracket to the mounting panel or chassis by means of suitable screws or bolts (maximum thread diameter = 4mm).

2. Insert the Controller through the aperture in the bracket and attach it to the bracket by means of the mounting clamp, in the same manner as for mounting a standard Controller to a mounting panel.

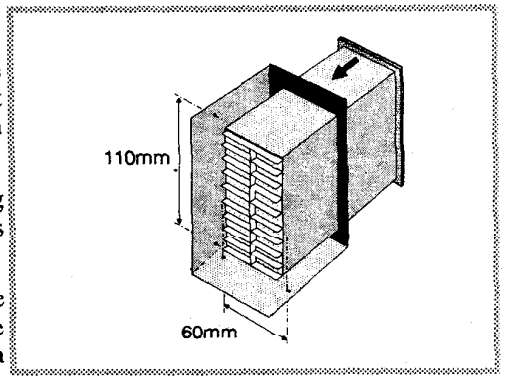



**Figure 2-3 Chassis Mounting Bracket**

### 2.3.3 Connecting the Controller to the Remote Front Panel

The Controller with a remote front panel is supplied with an inter-connecting cable. This is installed by inserting the two ends of the cable into the IDC sockets on the remote front panel and the front of the Controller (ensure that the plastic key on each of the cable connectors engages with the keyway in the corresponding connector). The connectors are secured in place by squeezing together the plastic retainer clips.

**CAUTION**

Do not run the inter-connecting cable in close proximity to power-carrying cables.

## 2.4 REMOVAL OF THE CONTROLLER FROM ITS HOUSING

The Controller can be removed from its housing (for servicing purposes or to replace sub-assemblies), leaving the housing and back-wiring attached to the mounting panel.

**CAUTION**

The mains (line) supply must be disconnected from the Controller before any attempt is made to remove the controller from its housing.

The Controller contains a lithium battery and devices which are sensitive to electrostatic discharge. During handling of the Controller, precautions should be taken to minimise the risk of electrostatic discharge or short-circuiting of the battery i.e.:

* Do not place the unhoused Controller on a conducting surface.

* Touch only the edges of the PCBs in the Controller. Ensure that fingers do not come into contact with any of the components or tracks on the PCB

* Before handling the unhoused Controller, touch a nearby ground connection e.g. a metal bench frame or rack.

* If possible, wear an earth wrist strap whilst handling the unhoused Controller.

IF BATTERY REPLACEMENT IS REQUIRED, THIS SHOULD BE PERFORMED BY A TRAINED TECHNICIAN.

To remove the Controller from its housing, proceed as follows:

1. With a flat-bladed screwdriver of appropriate size (1/4-inch), rotate the locking screw (see Figure 2-4) anticlockwise until the locking screw thread is completely dis-engaged. This will partially move the Controller out of the housing and dis-engage the connections at the rear of the Controller (inside the housing).

2. Carefully pull the Controller forwards clear of the housing.

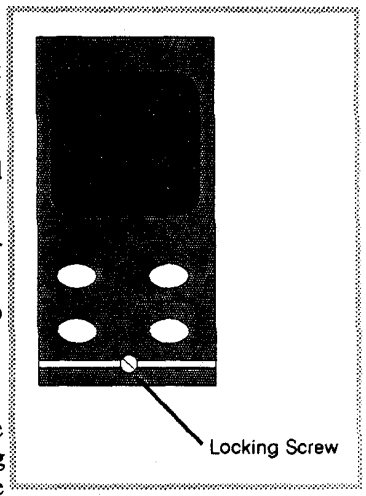



**Figure 2-4 Location of Locking Screw**

## 2.5 REPLACEMENT OF THE CONTROLLER IN ITS HOUSING

1. Carefully slide the Controller into its housing, ensuring that the Controller PCB(s) locate against the outside of the card guides moulded in the top and bottom of the housing.

2. Push the Controller firmly into place such that sound connection is made between the Controller PCBs' edge connectors and the rear connections inside the housing.

3. Engage the thread of the locking screw and tighten the locking screw until the Controller is securely in position in the housing.

## 2.6 CONNECTIONS AND WIRING

The following connections for outputs and inputs are provided at the rear of the Controller housing (with some controller configurations, some of the connections may not be present):

* Mains (Line) input

* Thermocouple, resistance temperature detector (RTD) or DC linear input

* Output 1 (HEAT) - Relay, solid state relay (SSR) or DC output.

* Output 2 (COOL) output (Relay, SSR or DC output) or Event Output (Relay).

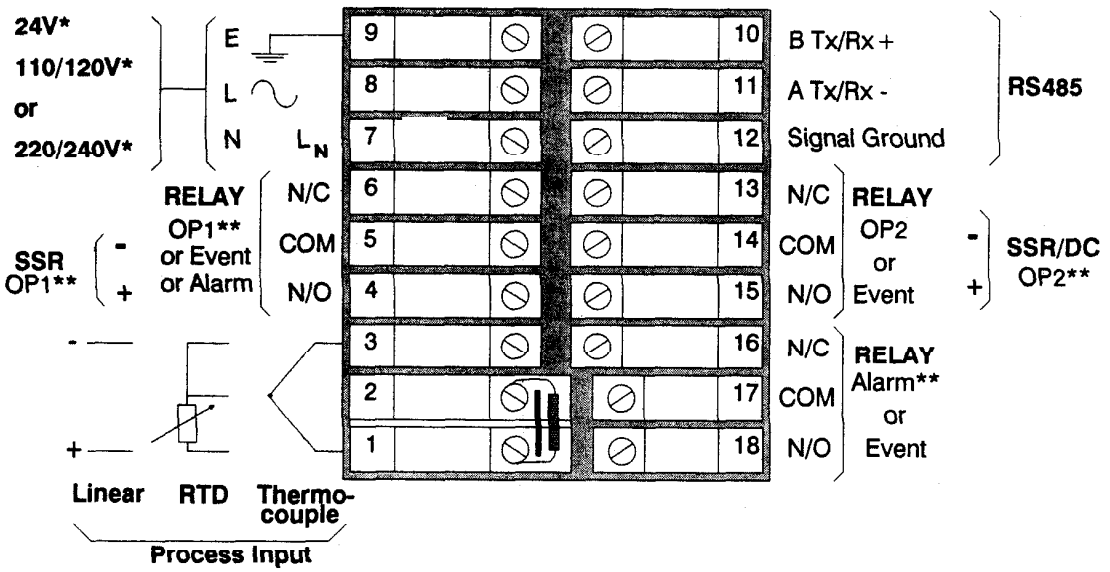
* Valve motor drive (VMD) output - open loop version

* Alarm output

* RS485-compatible serial communications input/output

* Recorder output

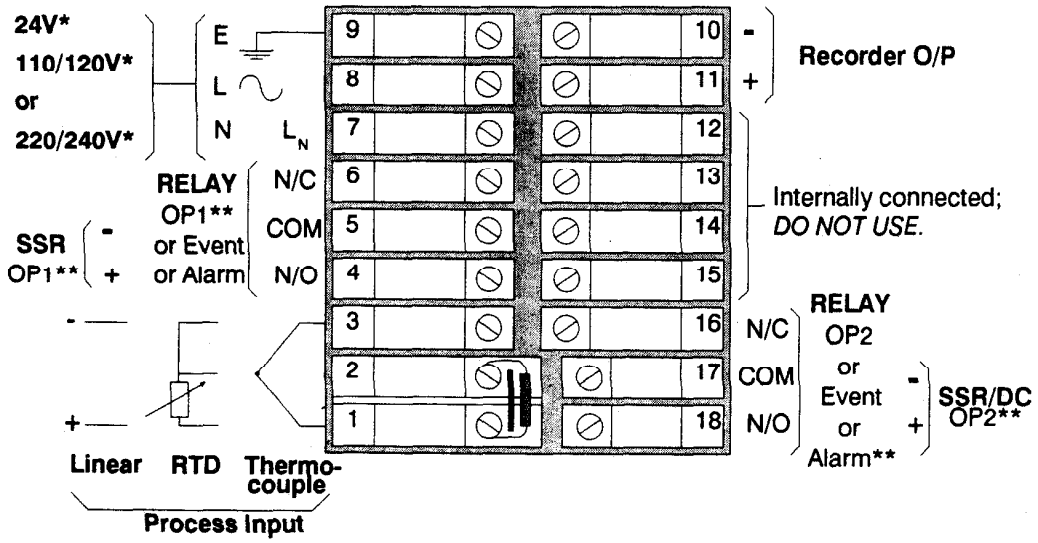
The connections to the rear terminals are shown in Figure 2-5 (for standard Controllers) and Figure 2-6 (for Controllers fitted with the Recorder Output option).




*50/60Hz

**When DC Output 1 is fitted (Product Codes H21, H24, H61 and H64), this is connected to Terminals 14 & 15; Relay Output 2 (C10) or Event Output (C0056 or C00--56) is connected to Terminals 4, 5 & 6 and SSR Output 2 (C50) is connected to Terminals 4 & 5. If DC Output 1, RS485 Communications and the Alarm (Relay) option are fitted, the Alarm output uses Terminals 4, 5 & 6.

**Figure 2-5 Rear Terminal Connections (Standard)**




*50/60Hz

**When DC Output 1 is fitted (Product Codes H21, H24, H61 and H64), this is connected to Terminals 17 & 18; Relay Output 2 (C10), Event Output (C0056 or C00--56) or Alarm relay (C00xx) is connected to Terminals 4, 5 & 6 and SSR Output 2 (C50) is connected to Terminals 4 & 5.

**Figure 2-6 Connections (with Recorder O/P)**

### 2.6.1 Mains (Line) Input

The Controller is supplied to operate on 24V, 100 - 132V or 193 - 264V AC supplies (50/60Hz). Check that the installation mains voltage corresponds to that indicated on the product code label before connecting power to the controller.

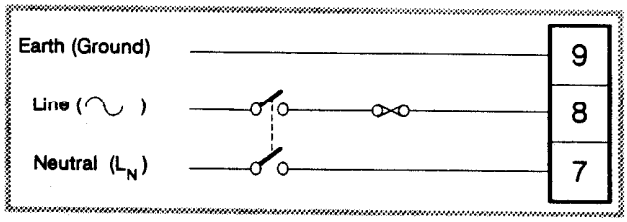



**Figure 2-7 Mains (Line) Supply Connections**

**CAUTION**

This equipment is designed for installation in an enclosure which provides adequate protection against electric shock. Local requirements regarding electrical installation should be rigidly observed. Ground terminals must be connected separately and must not be made common with the neutral connection. Consideration should be given to the prevention of unauthorised personnel from gaining access to the power terminations. The Ground terminal 9 should be connected to a protective ground conductor before any other connections are made and should remain connected at all times. Power should be connected via a two-pole isolating switch and a 1A (193 - 264V supply), 2A (100 -132V supply) or 5A (24V supply) fuse, as shown in Figure 2-7.

### 2.6.2 Thermocouple Input

Thermocouple input connections are shown in Figure 2-8. The correct type of thermocouple extension leadwire or compensating cable must be used for the entire distance between the Controller and the thermocouple, ensuring that the correct polarity is observed throughout. Joints in the cable should be avoided, if possible. All Controllers supplied with a thermocouple input have a cold junction compensation unit connected across terminals 1 and 2. This unit should never be removed.

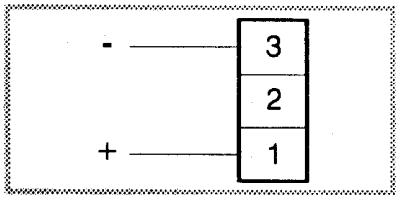



**Figure 2-8 Thermocouple Input Connections**

**NOTE**

Do not run thermocouple cables adjacent to power-carrying conductors. If the wiring is run in a conduit, use a separate conduit for the thermocouple wiring. If the thermocouple is grounded, this must be done at one point only. If the thermocouple extension lead is shielded, the shield must be grounded at one point only.

The colour codes used on the thermocouple extension leads are shown in Table 2-1.

**Table 2-1 Thermocouple Cable Colour Codes**

| Thermocouple Type | Cable Material | British (BS) | American (ASTM) | German (DIN) | French (NFE) |
|---|---|---|---|---|---|
| T | Copper Constantan | + white<br>- Blue<br>* Blue | + Blue<br>- Red<br>* Blue | + Red<br>- Brown<br>* Brown | + Yellow<br>- Blue<br>* Blue |
| J | Iron/Constantan | + Yellow<br>- Blue<br>* Black | + White<br>- Red<br>* Black | + Red<br>- Blue<br>* Blue | + Yellow<br>- Black<br>* Black |
| K | Nickel Chromium<br>Nickel Aluminium | + Brown<br>- Blue<br>* Red | + Yellow<br>- Red<br>* Yellow | + Red<br>- Green<br>* Green | + Yellow<br>- Purple<br>* Yellow |
| R<br>S | 13% Copper<br>10% Copper Nickel | + White<br>- Blue<br>* Green | + Black<br>- Red<br>* Green | + Red<br>- White<br>* White | + Yellow<br>- Green<br>* Green |
| B | Platinum/Rhodium | | + Grey<br>- Red<br>* Grey | | |

* Colour of overall sheath.

## 2.6.3 Three-wire Resistance Temperature Detector (RTD) Input

RTD connections are shown in Figure 2-9, with the compensating lead connected to Terminal 3. For two-wire RTD inputs, Terminals 2 and 3 should be linked. The extension leads should be of copper and the resistance of the wires connecting the resistance element should not exceed 5 ohms per lead (the leads should be of equal length).

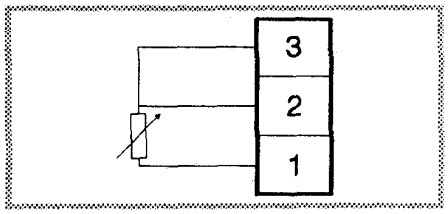



**Figure 2-9 Three-wire RTD Input Connections**

## 2.6.4 DC Linear Inputs

Any one of a range of linear inputs can be accommodated on the Controller (see Appendix B). Connections for linear inputs are as shown in Figure 2-10.

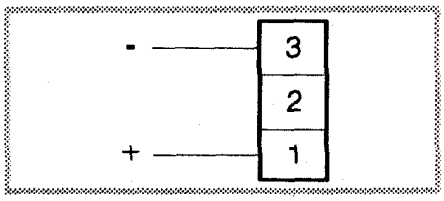



**Figure 2-10 DC Linear Input Connections**

## 2.6.5 Output 1 (Heat)

### 2.6.5.1 RELAY OUTPUT 1 (PRODUCT CODE --H10--)

The Output 1 relay has contacts connected to the rear terminals on the Controller. The contacts are rated at 5A 240V AC with a resistive load. When the relay is energised, the front panel **OP 1** indicator is illuminated. The connections for the Output 1 relay are as shown in Figure 2-11.

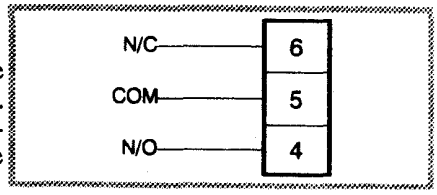



**Figure 2-11 Relay Output 1 Connections**

Refer also to Subsection 2.7.

### 2.6.5.2 SSR DRIVE OUTPUT 1 (PRODUCT CODE --H50--)

Controllers fitted with the SSR Output 1 produce a time-proportioned non-isolated DC signal (0V - 12V nominal, output impedance 250 ohms). This is suitable for driving the WEST 2200 Series Thyristor Units or other solid state relays with an isolated input. When Output 1 is ON, the front panel **OP 1** indicator will be illuminated. The connections are as shown in Figure 2-12.

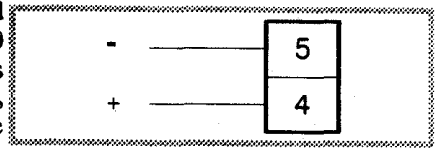



**Figure 2-12 SSR Drive Output 1 Connections**

### 2.6.5.3 DC OUTPUT 1 (PRODUCT CODES H21, H24, H61 & H64)

Refer to Appendix B for details of these outputs.

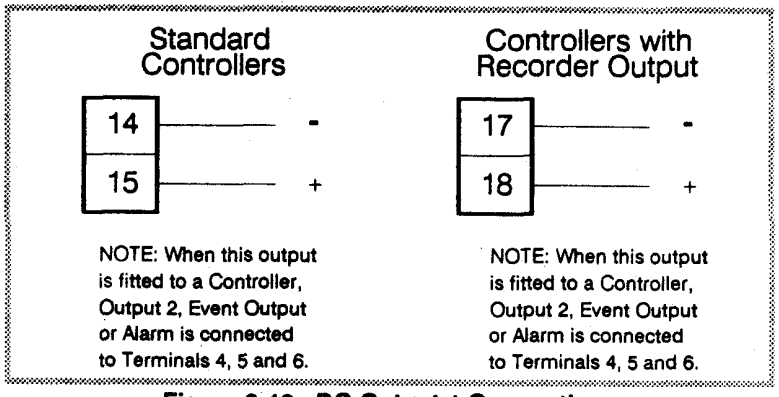

Standard Controllers
14
15
-
+
NOTE: When this output is fitted to a Controller, Output 2, Event Output or Alarm is connected to Terminals 4, 5 and 6.
Controllers with Recorder Output
17
18
-
+
NOTE: When this output is fitted to a Controller, Output 2, Event Output or Alarm is connected to Terminals 4, 5 and 6.

**Figure 2-13 DC Output 1 Connections**

## 2.6.6 Output 2 (Cool)

**NOTE**

If Output 1 is reverse-acting, Output 2 is direct-acting and vice versa.

### 2.6.6.1 OUTPUT 2 RELAY (PRODUCT CODE --C10--)

The Output 2 relay has single-pole double-throw contacts connected to the rear terminals as shown in Figure 2-14. The contacts are rated at 2A 240V AC with a resistive load. When the relay is energised, the front panel **OP 2** indicator is set ON. Refer also to Subsection 2.7.

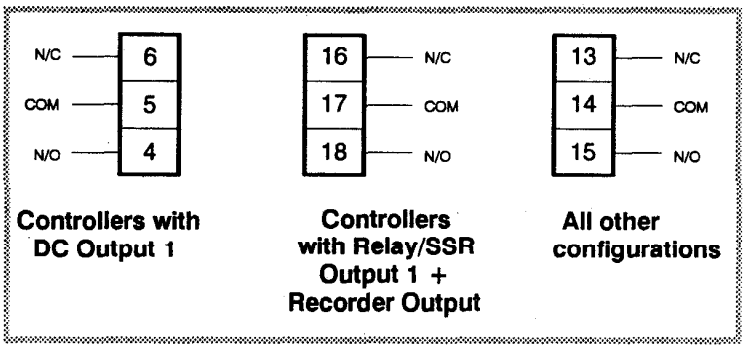



**Figure 2-14 Relay Output 2 Connections**

### 2.6.6.2 OUTPUT 2 SSR DRIVE (PRODUCT CODE --C50--)

Controllers with this output produce a time-proportioned non-isolated DC signal (0V/12V nominal, output impedance 250 ohms).

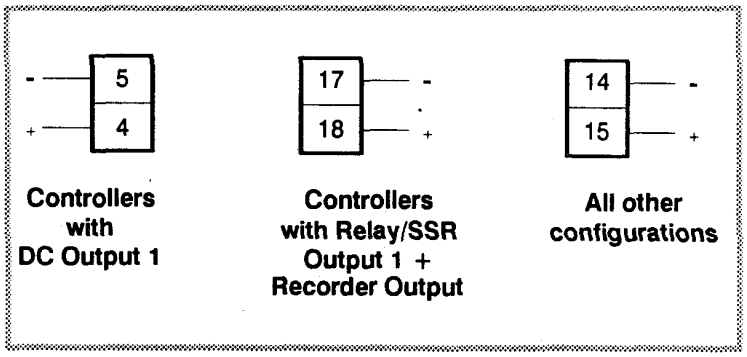



**Figure 2-15 Output 2 SSR Drive Connections**

### 2.6.6.3 DC OUTPUT 2 (PRODUCT CODES C21, C24, C61 OR C64)

Refer to Appendix B for details of these outputs.

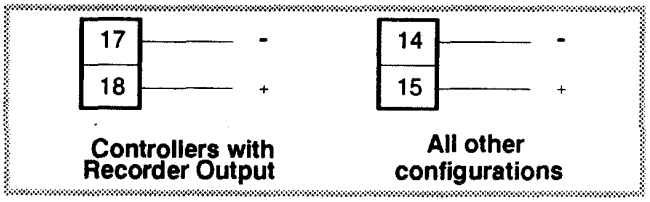



**Figure 2-16 DC Output 2 Connections**

## 2.6.7 VMD Open Loop Output

**NOTE**

When the VMD Open Loop output is fitted, the Event Output option is not available. The following mutually-exclusive additonal options are available:

RS485 Serial Communications

Alarm

Recorder Output

This output cannot be re-configured to any other type of output. The connections for a VMD Open Loop Output are shown in Figure 2-17. The Controller is designed to switch on either the Output 1 relay or the Output 2 relay (i.e. to open or close the valve). However, under fault conditions, both relays can be switched on simultaneously. An interlock can be provided for safety purposes (see Figure 2-18). This connects the supply to the motor via the "normally-closed" contacts on the relays. Refer also to Subsection 2.7.

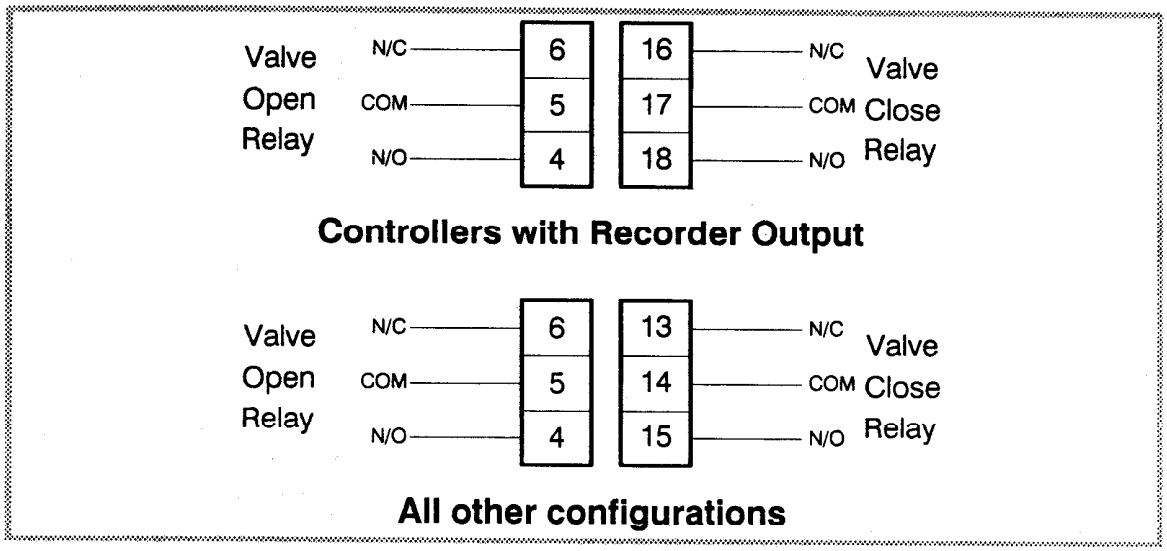



**Figure 2-17 VMD (Open Loop) Connections**

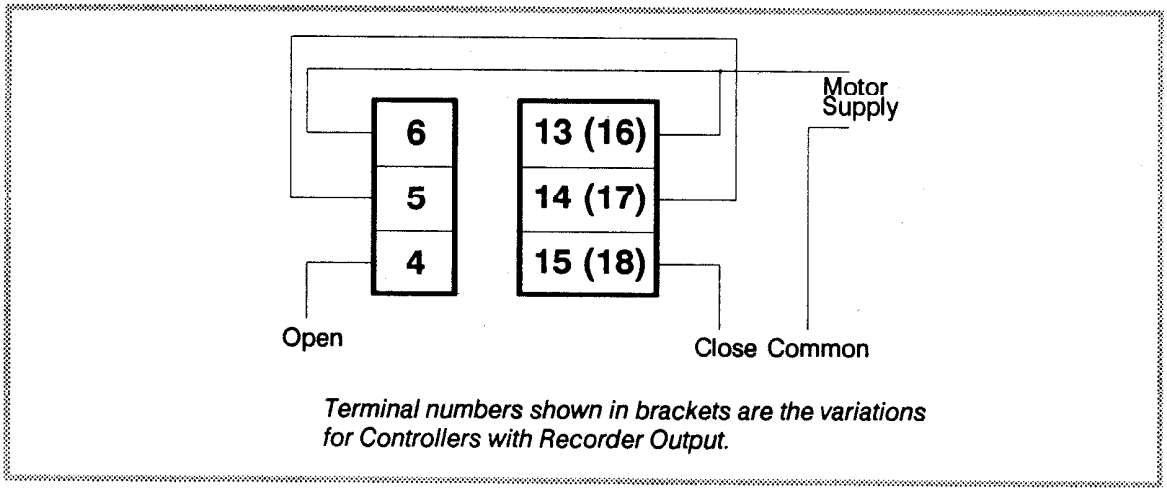



**Figure 2-18 VMD (Open Loop) - with Interlock**

## 2.6.8 Alarm Output - Optional (Product Codes --C--46 to --C--51)

The relay connections for an alarm output are shown in Figure 2-19. Details of the operations of the various types of alarms may be found in Subsection 4.6.

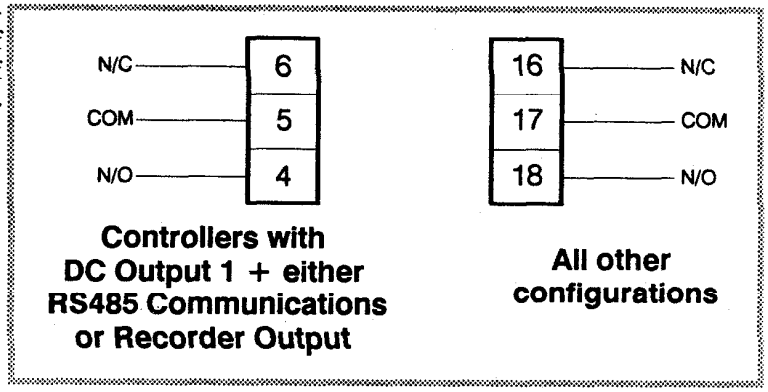



**Figure 2-19 Alarm Output Connections**

## 2.6.9 Event Output - Product Codes C0056, C00--56

The connections for the Event Output are shown in Figure 2-20. Controllers with the Event Output option are supplied configured for Output 2 (Cool). The Controller may be configured for an Event Output from the Controller front panel (see Subsection 4.5.4).

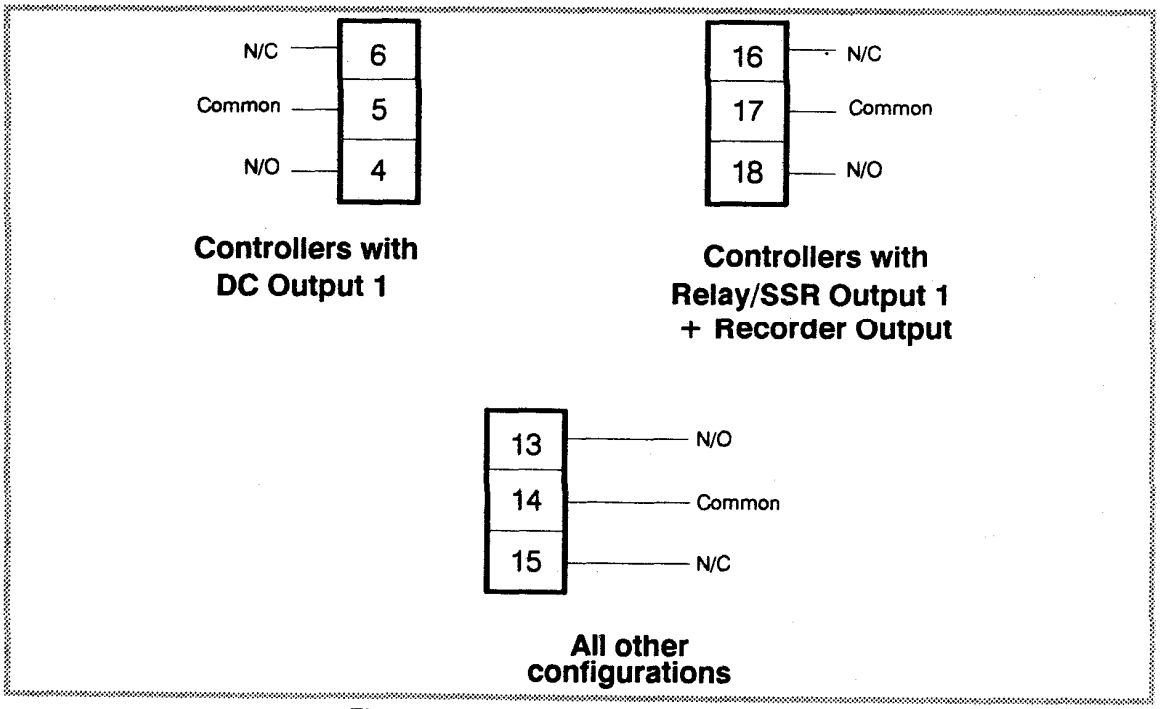



**Figure 2-20 Event Output Connections**

### 2.6.10 Recorder Output (Product Codes X12, X18, X19 and X20)

**NOTE**

This Option is not available with RS485 Communications (Product Code X06). Also, when this option is fitted, it is possible to have *only one of* Output 2, Event Output or Alarm output.

The connections for the Recorder Output are shown in Figure 2-21.

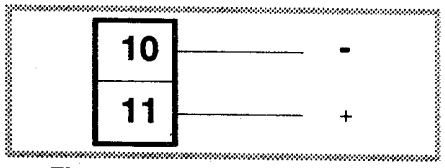



**Figure 2-21 Recorder Output Connections**

### 2.6.11 RS485-Compatible Serial Communications Link

Controllers which are fitted with the RS485 Communications Option (Product Code X06) use terminals 10, 11 and 12 as shown in Figure 2-22. Controllers fitted with this option are supplied configured for slave operation. The Controller may be configured for operation as a master device from the front panel (see Subsection 4.5.10). The RS485 communications operation is described in Section 5.

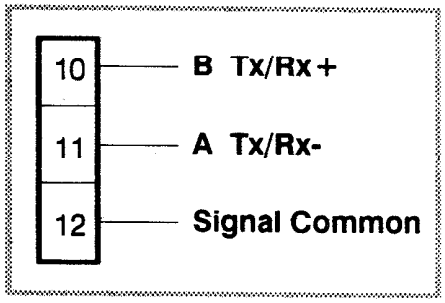



**Figure 2-22 RS485 Connections**

## 2.7 INDUCTIVE LOADS; EXTERNAL CONTACTORS AND MAINS-OPERATED RELAYS

**WARNING**

Operating the Controller with inductive loads and without the appropriate protection components may give rise to a hazard owing to high-voltage transients which may occur during the switching cycles. *Removal of the Controller's internal snubber components could give rise to a serious hazard. Gulton Limited and Mark IV Industries do not accept responsibility for any damage which may occur as a consequence of the unauthorised removal of these components.*

### 2.7.1 General Notes

The standard relay contacts fitted in the Controller are suitable for AC supply voltages in the range 24V to 240V. The Output 1 relay is rated at up to 5A with a resistive load and up to 1A with an inductive load. The Alarm and Output 2/Event Output relays are rated at up to 2A with a resistive load and up to 1A with an inductive load. The Model 3750 Controller contains voltage-dependent resistors (VDRs) across all relay contacts; these protect the internal circuits for all loads up to the maximum rating. No external protection components are necessary unless an external switch or contact is fitted in series with the Controller relay contacts (see Subsection 2.7.2).

## 2.7.2 An External Switch in Series with an External Inductive Load

Damage may be caused to the Controller if the contacts of a switch, relay or contactor are connected externally in series with the Controller relay contacts, as shown in Figure 2-24.

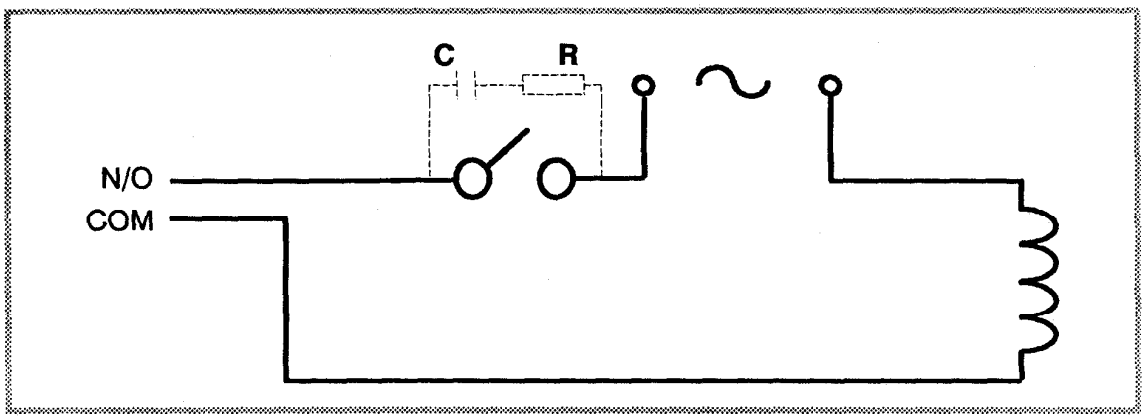



**Figure 2-23 External Switch/Inductive Load in Series**

Under these conditions, the external contacts may operate whilst the Controller relay contacts are closed (i.e. when the internal protection components are short-circuited and, therefore, ineffective).

In applications in which it is necessary to fit the contacts of an external switch, relay or contactor in series with the Controller relay, a suitable VDR or a snubber network must be fitted, either across the inductive load or across the unprotected contacts (the components shown in dotted outline in Figure 2-24). The values shown in Table 2-2 may be used for these components.

**Table 2-2 Protection Network Component Values**

| Load Current | Value of C($\mu$F) | West Part No. | Value of R($\Omega$) | West Part No. |
|---|---|---|---|---|
| 70mA | 0.047 | 22206 | 22 | 23220-304 |
| 150mA | 0.100 | 22207 | 47 | 23470-304 |
| 500mA | 0.220 | 22208 | 47 | 23470-304 |
| 1A | 0.470 | 22209 | 47 | 23470-304 |

**NOTE**

All capacitors should conform to VDE (Class X) and should be suitable for operation at 260V AC. All resistors (wirewound or Allen Bradley Type HB) should have a minimum rating of 2 watts.

# SECTION 3
# OPERATING INSTRUCTIONS

## 3.1 INTRODUCTION

These instructions are based on the assumption that the Controller has been set up and is in User Mode.

The set point and process variable values are displayed. If the profile is not running, the set point value is adjustable from the front panel. The operator may select to start the profile, hold or abort the profile (if it is currently running), may jump from one segment of the currently-running profile to the next or may choose (if Auto/Manual selection is enabled) manual control of the process.

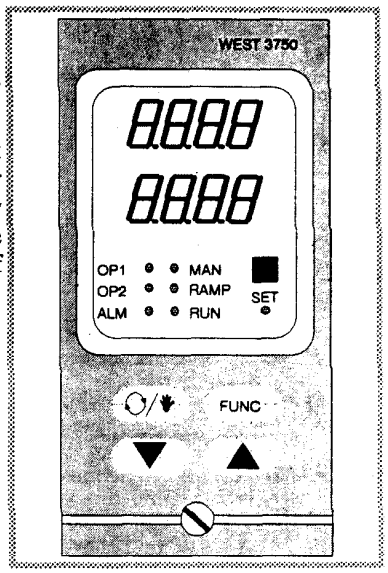



**Figure 3-1 3750 Controller - Front Panel**

## 3.2 DISPLAYS (USER MODE)

**Profile Not Running:**

Upper Display: This normally displays the value of the process variable.

Lower Display: This normally displays the set point value or, if Manual control is selected, the output power value (in the form **Pxxx**).

If the **FUNC** key is depressed, the set point legend **SP** will be displayed in the lower display and the set point value will appear in the upper display; this may be adjusted using the Raise/Lower keys. A further depression of the **FUNC** key will cause a return to the normal display.

**Profile Running:**

Upper Display: This normally displays the value of the process variable. If the **FUNC** key is depressed, either of the two dwell set point values is displayed, dependent upon which segment of the profile is currently running.

Lower display: This normally displays the current set point value. If the **FUNC** key is depressed, the legend **dSP1** or **dSP2** will appear to indicate that the value in the upper display is that of Dwell Set Point 1 or Dwell Set Point 2.

A second depression of the **FUNC** key will either return the controller to the normal display mode or cause the number of cycles completed to be displayed

### NOTE

The units for the process variable (e.g. $^{o}$F or $^{o}$C) are displayed in a window on the lower right of the display group.

## 3.3 FRONT PANEL INDICATORS

**OP 1** This indicates the state of the Output 1 relay or SSR drive:

ON = relay energised or SSR drive ON

OFF = relay de-energised or SSR drive OFF

or (on Controllers fitted with the VMD Output Option) this indicator being ON indicates that the valve is opening.

**OP 2** Optional - This indicates the state of the Output 2 relay or SSR drive:

ON = relay energised, SSR drive ON or Event Output relay energised

OFF = relay de-energised, SSR drive OFF or Event Output relay de-energised

or (on Controllers fitted with the VMD Output Option) this indicator being ON indicates that the valve is closing.

**ALARM** (Optional) This indicator flashes to indicate an Alarm condition (see Subsection 4.6 for details of alarm operation).

**RAMP** This indicator is ON if the profile is currently executing a ramp.

**MAN** Not applicable if Auto/Manual selection is disabled - This flashes when Manual Control has been selected.

**SET** This indicates that Set-Up Mode is selected (see Section 4 for details of Set-Up Mode).

**RUN** This indicator is ON if a profile is currently running and flashes when a profile is Held.

## 3.4 FRONT PANEL CONTROLS

Raise key. Used to increase the value of the selected parameter, if a profile is not running.

Lower key. Used to decrease the value of the selected parameter, if a profile is not running.

Run-Time key. Used to select/de-select Run-Time Mode and to select any option in that mode.

Selects parameters in sequence for display.

## 3.5 SELF-TEST PROCEDURE

When the Controller is powered-up, a self-test procedure is automatically started, during which all LED segements in the two front panel displays appear and all LED indicators are ON. When the self-test procedure is complete, the Controller reverts to normal operation.

## 3.6 NORMAL DISPLAY

On completion of the self-test procedure, the Controller is in User Mode. The upper display indicates the current value of the process variable and the lower display indicates the current value of the set point.

## 3.7 USER MODE INSTRUCTIONS

### 3.7.1 Set Point Adjustment (Profile Not Running)

The value of the set point may be adjusted from the front panel as follows:

1. Depress the **FUNC** pushbutton. The lower display will show the legend:

The upper display will show the current value of the set point.

2. Adjust the set point value using the Raise and Lower keys as applicable.

**NOTE**

When either the Raise or Lower key is depressed momemtarily, the set point value will be incremented or decremented (as appropriate) by one unit. If the key is held depressed for longer than one second, the set point value is incremented or decremented (as appropriate) at the rate of 25 units per second. If the key is held depressed for longer than 10 seconds, the set point value will change at the rate of 250 units per second.

3. When the set point has been adjusted to the required value, return to the normal display mode by depressing the **FUNC** key.

### 3.7.2 Dwell Set Point Adjustment and Cycle Count (Profile Running)

If the profile is running and dwell set point changes have not been disabled, the value of the current profile dwell set point can be temporarily changed as follows:

1. Depress the **FUNC** pushbutton. The lower display will show one of the following legends:

First ramp or dwell period

Second ramp or dwell period

If the profile is executing the first ramp, **dSP1** is the final value of set point for that ramp. If the profile is currently in the first dwell period, **dSP1** is the constant value of set point during that dwell period. The parameter **dSP2** applies to the second ramp or dwell period in a similar manner. The upper display will show the current value of the profile dwell set point.

2. Adjust the set point value using the Raise and Lower keys as applicable.

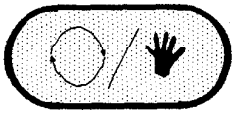
3. When the set point is at the required value, depressing the **FUNC** key will either cause a return to the normal display mode or (if **CYCL** > 1) cause the lower display to show the legend:

and the upper display to show the number of cycles of the profile currently completed. In the latter case another depression of the **FUNC** key will cause a return to Normal Display Mode.

## NOTE

The new value of the dwell set point will be valid only for the current execution of the profile. It does not change the value permanently held in the profile parameters.

## 3.8 RUN-TIME MODE INSTRUCTIONS



Run-Time Mode may be entered at any time - even when the Controller is in Set Up Mode. Run-Time Mode is selected by simply depressing the Run-Time key. In Run-Time Mode, the operator may (a) start the profile running (if it is not already doing so), (b) hold (suspend) a currently-running profile (the set point will be frozen at its value when the Hold condition started), (c) abort a currently-running or currently-held profile (the process will be released to automatic or manual control, as selected, with the value of set point defined by the controller set point **SP** parameter), (d) jump to the next segment of the currently-running profile or (e) select manual or automatic control of the process (if manual control selection has been enabled in Set Up Mode - see Section 4).

When Run-Time Mode is first entered, the Controller will initially display one of the following:

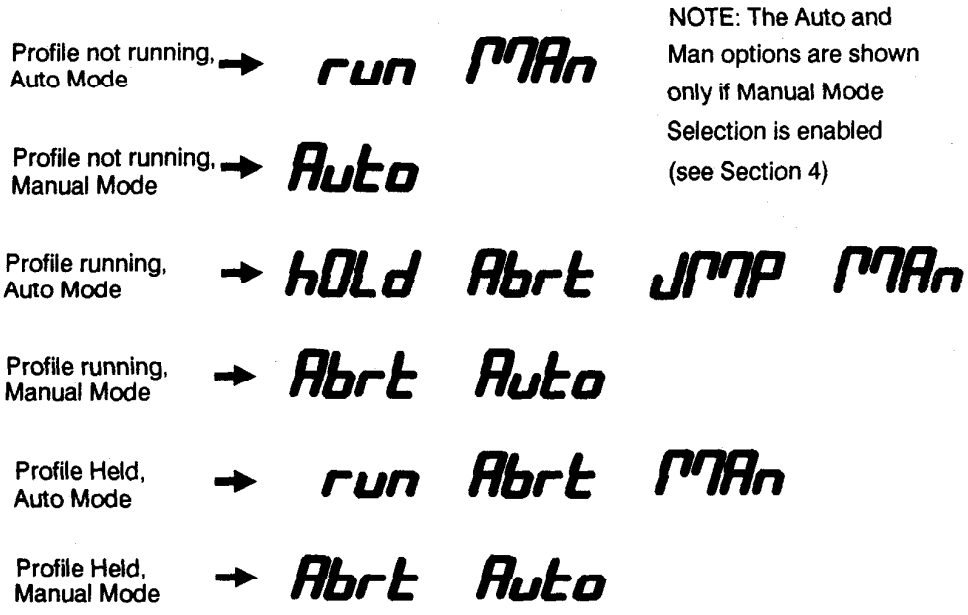
Profile Held/not running, Auto Mode

Profile not running, Manual Mode

Profile running, Auto Mode

Profile running/Held, Manual Mode

The operator may then step through the Run-Time options (on the upper display) by depressing the **FUNC** key to make each step. The sequence is dependent upon the mode in which the Controller is currently operating:




NOTE: The Auto and Man options are shown only if Manual Mode Selection is enabled (see Section 4)

If the last option in a sequence is displayed, a subsequent depression of the **FUNC** key will cause an exit from Run-Time Mode. If the **FUNC** key is held depressed, the display will scroll through the appropriate sequence and will then exit from the Run-Time Mode. When the desired option is displayed, it is selected by depressing the Run-Time key. Upon selection of an option, the appropriate action is implemented and an exit is made from the Run-Time Mode.

## NOTE

The Raise and Lower keys serve no function in Run-Time Mode.

### 3.8.1 Selecting Manual Control

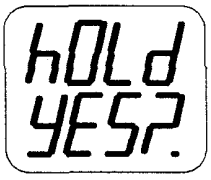
## CAUTION

Extreme caution should be exercised in the use of the Manual Control facility to avoid the possibility of damage to either the process or the process equipment.

To select Manual Control (on a Controller which is currently in Auto Mode):

1. Depress the Run-Time key; the Controller will display:

If the profile is Held/not currently running




If the profile is currently running

2. Depress the **FUNC** key until the upper display shows:

3. Depress the Run-Time key. The process will come under Manual Control and the Controller will exit Run-Time Mode. The **MAN** indicator will flash, the upper display will show the process variable value and the lower display will show the percentage power output in the form:

The value of output power may be adjusted using the Raise and Lower keys as required. The output power value can be varied in the range 0% - 100% for controllers fitted with Output 1 only, or in the range -100% - +100% for controllers fitted with both Output 1 and Output 2.

## NOTES

1. On Controllers with the VMD Output Option, in Manual Control Mode, the Raise and Lower keys are used as follows:

   (a) The Raise key is used to energise the Open Valve relay and will cause the **OP 1** indicator to go ON.

   (b) The Lower key is used to energise the Close Valve relay and will cause the **OP 2** indicator to go ON.

## NOTES (Continued)

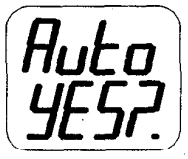
2. If the Controller is powered-down whilst in Manual Control mode, it will remain in Manual Control mode when power is restored to the Controller. The power output level will be as it was at the instant of power-down.

### 3.8.2 Selecting Auto Control Mode

To select Auto Control Mode (on a Controller which is currently in Manual Mode):

1. Depress the Run-Time key; the Controller will display:

If the profile is Held or currently running




If the profile is not currently running

2. If the profile is Held (**RUN** indicator flashing) or is currently running (**RUN** indicator ON), depress the **FUNC** key until the upper display shows:

3. Depress the Run-Time key.

The Controller will assume automatic control of the process and will return to Normal Display Mode (showing the process variable value in the upper display and the set point value in the lower display.

### 3.8.3 Starting/Resuming a Profile

With the Controller in Auto Mode, a profile can be started (if not running) or released (if Held) as follows:

1. Depress the Run-Time key. The controller will display:

2. Depress the Run-Time key again. The Controller will exit Run-Time Mode and the profile will be started/re-started.

### 3.8.4 Holding (Suspending) a Currently-Running Profile

With the Controller in Auto Mode, a currently-running profile can be Held as follows:

1. Depress the Run-Time key. The Controller will display:

2. Depress the Run-Time key again. The profile will be suspended, with the set point frozen at its value at the instant of suspension.

### 3.8.5 Aborting a Profile

A currently-Held or currently-running profile may be aborted as follows:

1. Depress the Run-Time key. The Controller will display one of the following:

Profile Held/not running, Auto Mode

Profile running, Auto Mode

Profile running/Held, Manual Mode

2. If the Controller is in Auto Mode, depress the **FUNC** key until the upper display shows:

3. Depress the Run-Time key. The profile is instantly aborted and the Controller will display the process variable value in the upper display; the lower display will show:

4. Depress the Raise key or the Lower key to return to Normal Display Mode.

### 3.8.6 Jumping to the Next Segment of a Currently-Running Profile

With the Controller in Auto Mode and currently executing a profile, a jump from the current segment of the profile to the next segment may be implemented as follows:

1. Depress the Run-Time key. The Controller will display:

2. Depress the **FUNC** key until the upper display shows:

3. Depress the Run-Time key. The Controller will immediately advance the profile to the start of the next segment and an exit will be made from Run-Time Mode.

### 3.8.7 Making an Exit from Run-Time Mode

When an exit is made from Run-Time Mode, the Controller displays return to the status active immediately prior to the selection of Run-Time Mode, with the following exceptions:

(a) Upon selecting Manual Mode, the displays will show the process variable value (upper display) and the percentage power output (lower display).

(b) Upon selecting Auto Mode, the Controller will always return to Normal Display Mode.

(c) Upon aborting a profile, the displays will immediately show the process variable value (upper display) and, in the lower display, the legend:

Depression of the Raise key or the Lower key will then cause a return to Normal Display Mode.

## 3.9 DEFAULT PARAMETER INDICATION

If the Controller is operating with default values, the upper display will show a decimal point after each digit of the displayed value.

See Section 4 for details of setting up control parameter values.

## 3.10 REMOTE CONTROL VIA THE RS485-COMPATIBLE LINK

If the controller is fitted with the RS485-compatible serial communications facility (Option X06) and this has been enabled (see Section 5), parameters may be changed via this communications link.

# SECTION 4
# SETTING-UP PROCEDURES

## 4.1 TO ENTER SET-UP MODE

With the Controller in User Mode, and the upper display showing the current value of the process variable and the lower display showing the current value of the set point, proceed as follows:

1. Depress and hold down the Raise and Lower keys simultaneously until the front panel **SET** indicator starts to flash.

2. Within three seconds of the **SET** indicator starting to flash, depress and hold down the **FUNC** key until the **SET** indicator is continuously ON.

The Controller is now in Set-Up Mode and will initially display:

(Profile Data)

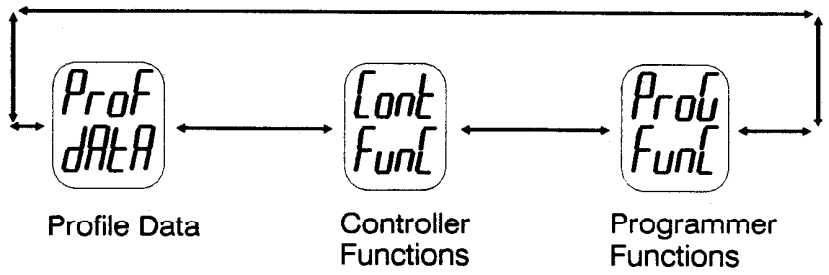
This is the first of a sequence of three header displays which gives access to the three categories of functions in Set Up Mode:

1. Profile Data: defines the final set point value and duration/rate for each ramp period, duration of each dwell period, use of Event Output during running of the profile and the number of cycles of the profile to be executed.

2. Controller Functions: parameters which define the way in which control is exercised on the process variable.

3. Programmer Functions: Defines the guaranteed soak hysteresis, use of Track and Hold facility, timescales of the profile (hours/minutes or minutes/seconds), selection of Output 2 or Event Output, ramp programming method, profile start point, power fail strategy and ability to change the dwell set points whilst the profile is running

The operator may step through this sequence of header displays by depressing the Raise or Lower key for each step. The full sequence is:




When the desired header is displayed, the operator may select the opening display in the sequence for that set by depressing the **FUNC** key, whereupon the display sequence for that set may be stepped through *in a forward direction only* by depressing the **FUNC** key at each step. When the last parameter/function in each set is displayed, depression of the **FUNC** key will cause the corresponding header display to appear again. If the **FUNC** key is held down, the Controller will advance through the display sequence until either the **FUNC** key is released or the header is displayed again. Each display will show the value/setting of the selected parameter/function (in the upper display) and the legend which identifies that parameter (in the lower display). While each parameter is displayed, the operator may adjust the value of that parameter, within the permitted range, by use of the Raise (to increment) and Lower (to decrement) keys. The upper and lower displays will flash if the operator attempts to:

(a) adjust a parameter to a value outside the range of adjustment,
(b) adjust a parameter to a value beyond the limit set by another parameter (e.g. SP Limit),
(c) adjust a "read only" parameter (e.g. process variable).

In such instances, the attempted adjustment will not be implemented.

When initially setting up the Controller, the Controller Function and Programmer Function parameters (see Subsections 4.3 and 4.4) should be set *before* entering the Profile Data. Subsequently, in most applications, adjustment will only be necessary to the Profile Data.

**NOTE**

In Set-Up Mode, if one minute elapses during which no key is operated, the Controller will return automatically to User Mode.

## 4.2 PROFILE DATA

When Profile Data is selected, the Controller will display the first in the Profile Data display sequence. The full sequence is as follows:

| If the **Rate** ramp programming method has been selected (see Subsection 4.4) | | If the **Time** ramp programming method has been selected (see Subsection 4.4) | |
|---|---|---|---|
| FSP1 | Final set point value for Ramp 1 | FSP1 | Final set point value for Ramp 1 |
| rtr1 | Rate (per hour) change for Ramp 1 | t r1 | Time (duration) for Ramp 1 |
| Etr1 | Event Output state during Ramp 1* | Etr1 | Event Output state during Ramp 1* |
| t d1 | Time (duration) of Dwell 1 | t d1 | Time (duration) of Dwell 1 |
| Etd1 | Event Output state for Dwell 1* | Etd1 | Event Output state for Dwell 1* |
| FSP2 | Final set point value for Ramp 2 | FSP2 | Final set point value for Ramp 2 |
| rtr2 | Rate (per hour) change for Ramp 2 | t r2 | Time (duration) for Ramp 2 |
| Etr2 | Event Output state during Ramp 2* | Etr2 | Event Output state during Ramp 2* |
| t d2 | Time (duration) for Dwell 2 | t d2 | Time (duration) for Dwell 2 |
| Etd2 | Event Output state for Dwell 2* | Etd2 | Event Output state for Dwell 2* |
| CYCL | Number of cycles of the profile to be executed | CYCL | Number of cycles of the profile to be executed |

* Displayed only if Event Output option is fitted and enabled.

A typical profile is illustrated in Figure 4-1 and comprises two ramps and two dwell periods which are defined using these parameters.

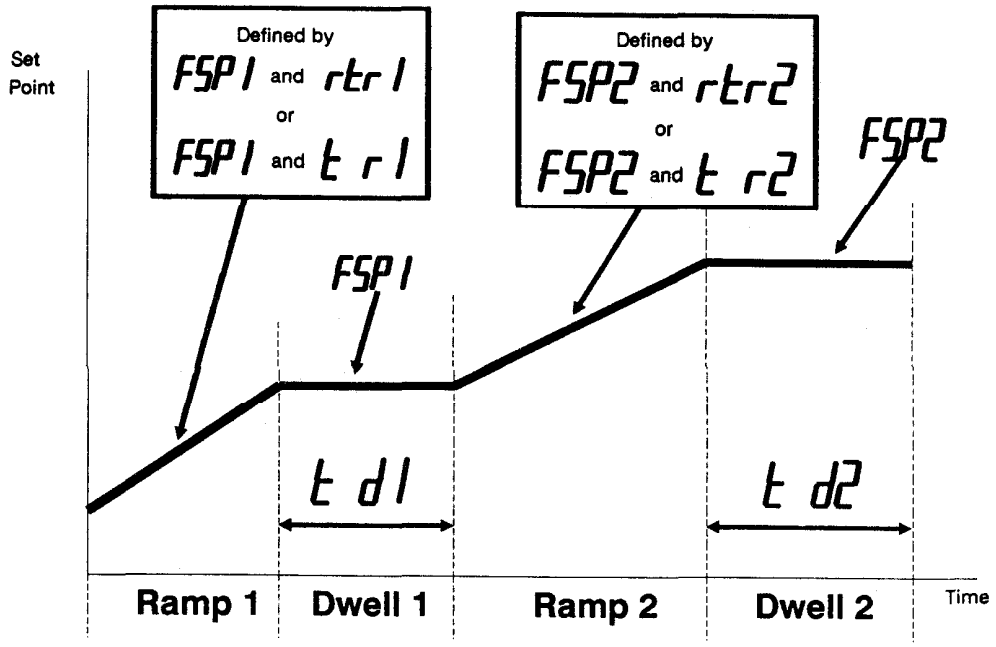



**Figure 4-1 A Typical Profile**

### 4.2.1 Final Set Point 1 - FSP1

This parameter is the value of the set point at the end of the first ramp period; this value will be maintained throughout the first dwell period. This parameter may be adjusted within the range Set Point Low Limit (**SPLo**) - Set Point High Limit (**SPhi**) - see Subsection 4.3.

### 4.2.2 Ramp 1 Change Rate - rtr1 (Rate Ramp Programming Mode Only)

This defines the rate of change of the set point during the first ramp (in units/hour or, if the "x60" function **bY60** is set to YES, in units/minute - see Subsection 4.5.3). It may be in the range 1 - 9999. The default value is 60 or 6.0 (dependent upon the input range fitted - see Subsection 6.2).

### 4.2.3 Ramp 1 Time - t r1 (Time Ramp Programming Mode Only)

This defines the duration of Ramp 1 in hours and minutes (or, if the "x60" function **bY60** is set to YES, in minutes and seconds - see Subsection 4.5.3). It may be set to a value in the range 0 - 99:59. The default setting is 01:00.

### 4.2.4 Ramp 1 Event Output State - Etr1

This function is applicable only if the Event Output option has been fitted and enabled; it defines the state (ON or OFF) of the Event Output during Ramp 1. The default setting is OFF.

### 4.2.5 Dwell 1 Time - t d1

This defines the duration of the first dwell (soak) period in hours and minutes (or, if the "x60" function **bY60** is set to YES, in minutes and seconds - see Subsection 4.5.3). It may be adjusted within the range 0 - 99:59; selection of a value greater than 99:59 causes the first dwell period to continue indefinitely. The default value is 1:00.

### 4.2.6 Dwell 1 Event Output State - Etd1

This function is applicable only if the Event Output option has been fitted and enabled; it defines the state (ON or OFF) of the Event Output during the first dwell period. The default setting is OFF.

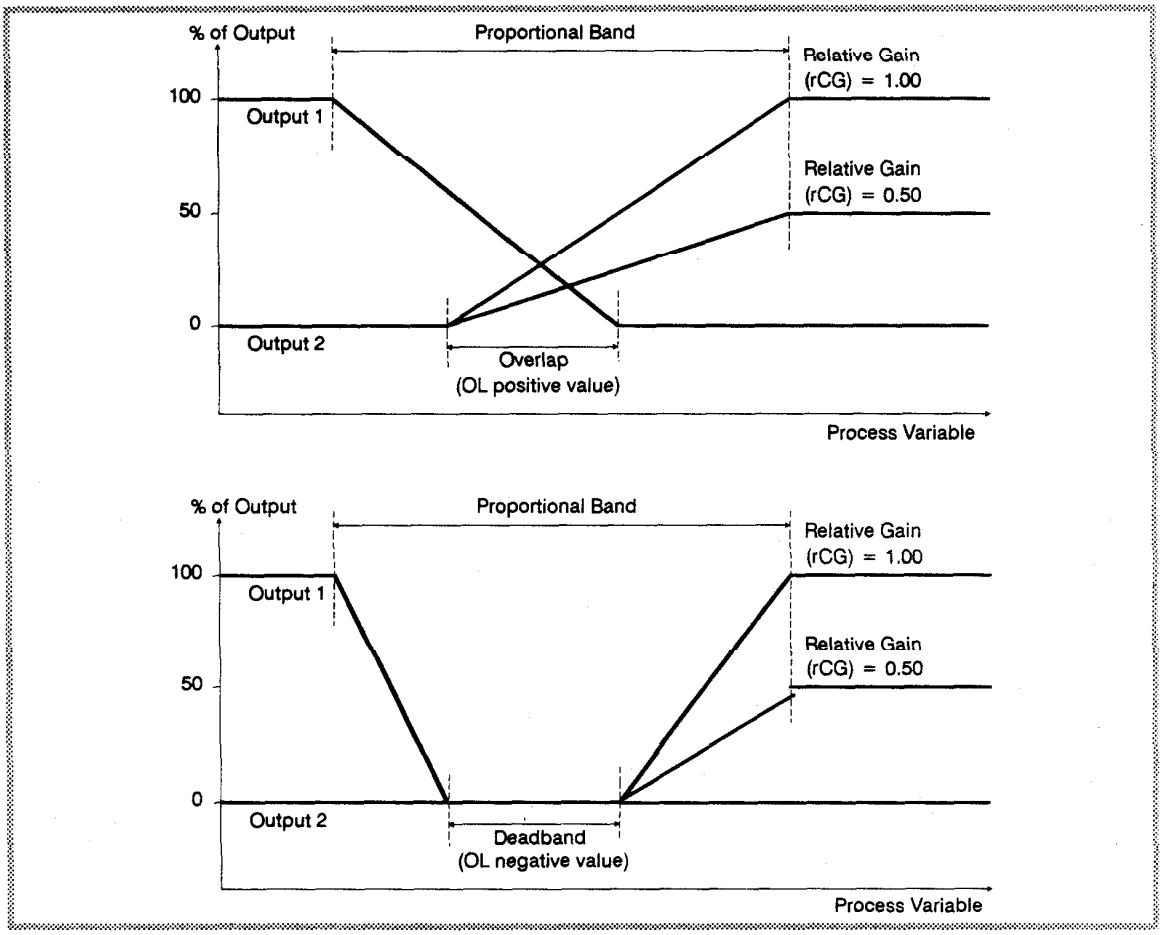



**Figure 4-2 Overlap/Deadband - OP 1 and OP2 Fitted**

### 4.2.7 Final Set Point 2 - FSP2

This parameter is the value of the set point at the end of the second ramp period; this value will be maintained throughout the second dwell period. This parameter may be adjusted within the range Set Point Low Limit (**SPLo**) - Set Point High Limit (**SPhi**) - see Subsection 4.3.

### 4.2.8 Ramp 2 Change Rate - rtr2 (Rate Ramp Prorgamming Mode Only)

This parameter defines the rate of change of the set point during the second ramp (in units/hour or, if the "x60" function **bY60** is set to YES, in units/minute - see Subsection 4.5.3). It may be set to a value in the range 1 - 9999. The default value is 60 or 6.0 (dependent upon the input range fitted - see Subsection 6.2).

### 4.2.9 Ramp 2 Time - t r2 (Time Ramp Programming Mode Only)

This parameter defines the duration of Ramp 2 in hours and minutes (or, if the "x60" function **bY60** is set to YES, in minutes and seconds - see Subsection 4.5.3). It may be set to a value in the range 0 - 99:59. The default setting is 01:00.

### 4.2.10 Ramp 2 Event Output State - Etr2

This function is applicable only if the Event Output option has been fitted and enabled; it defines the state (ON or OFF) of the Event Output during Ramp 2. The default setting is OFF.

### 4.2.11 Dwell 2 Time - t d2

This defines the duration of the second dwell (soak) period in hours and minutes (or, if the "x60" function **bY60** is set to YES, in minutes and seconds - see Subsection 4.5.3). It may be adjusted within the range 0 - 99:59; selection of a value greater than 99:59 causes the second dwell period to continue indefinitely. The default value is 1:00.

### 4.2.12 Dwell 2 Event Output State - Etd2

This function is applicable only if the Event Output option has been fitted and enabled; it defines the state (ON or OFF) of the Event Output during the second dwell period. The default setting is OFF.

### 4.2.13 Number of Cycles - CyCL

This defines the number of times the profile is to be executed automatically. It may be set to a value in the range 1 - 9999; if a value greater than 9999 is set, the profile will cycle indefinitely.

## 4.3 CONTROLLER FUNCTIONS

When Controller Functions are selected in Set Up Mode, the Controller initially displays the current value of the process variable (in the upper display) and the current value of the set point (in the lower display). Depression of the **FUNC** key will start the display sequence for the Controller Functions. The Controller Functions parameters are explained in the following Subsections, after which the Controller Functions are summarised in Table 4-1.

### 4.3.1 Set Point - SP

This is the initial value of the process variable. It can be adjusted within the range defined by the Set Point High Limit (**SPhi**) and the Set Point Low Limit (**SPLo**). This parameter cannot be adjusted while the profile is running.

### 4.3.2 Output Power - OP

This is the Output 1 power level. It can only be adjusted in Manual Control Mode, otherwise it is a "Read Only" parameter. The adjustment range is -100% to + 100% (or 0% to + 100% on Controllers with Output 1 only). This parameter is not available on Controllers which have the VMD Output Option (Product Code H70) fitted.

### 4.3.3 Proportional Band - Pb

The Proportional Band can be set to a value between 0% and 1000% of the span of the controller. If the Proportional Band is set to 0%, the controller operates in an ON/OFF Mode.

### 4.3.4 Integral Time Constant - rSEt

This can be set to a value between 10 seconds and 30 minutes. If the Integral Time Constant is set to a value greater than 30 minutes, the upper display goes blank and integral control is disabled. This parameter is omitted from the sequence if the Proportional Band is set to 0%.

### 4.3.5 Derivative Time Constant - rAtE

This can be set to a value between 0 seconds and 10 minutes. This parameter is omitted from the sequence if Proportional Band = 0%.

### 4.3.6 Relative Gain - rCG

This defines the Output 2 gain relative to Output 1, within the Proportional Band and the maximum Output 2 outside the Proportional Band. It can be set to a value between .02 and 1.00. If **rCG** > 1.00, the upper display goes blank and Output 2 operates in an ON/OFF mode.

### 4.3.7 Overlap/Deadband - OL

This defines the area within the Proportional Band in which Output 1 and Output 2 are both active (0% to 20%) or the area within the Proportional Band in which Output 1 and Output 2 are both inactive (0% to -20%).

### 4.3.8 On/OFF Differential - diF1, diF2 or diFF

This parameter is included in the sequence only if Proportional Band = 0% or if Output 2 is set to ON/OFF Mode (Relative Gain 1.00). It applies to Output 1 and Output 2 if Proportional Band = 0%. It applies only to Output 2 if Output 2 is set to ON/OFF Mode (Relative Gain > 1.00). This parameter provides a deadband to prevent too-frequent load switching and can be set to a value between 0.1% and 10% of the span of the controller.

### 4.3.9 Set Point Minimum and Set Point Maximum - SPhi & SPLo

These should be set to values such that, in User Mode, the operator cannot adjust the Set Point to a value which might cause damage.

### 4.3.10 Recorder Output Scale Maximum - roPH

This parameter defines the maximum scale value of the Recorder Output (Terminals 10 and 11) and may be adjusted over the range -1999 to 9999. The decimal point position for the Recorder Output scaling always corresponds to that for the process variable input range. If the Recorder Output Scale Maximum is adjusted to be less than the Recorder Output Scale Minimum, the relationship between the process variable value and the Recorder Output is reversed. Example: For a 0 - 5V recorder output, this value corresponds to 5V output.

### 4.3.11 Recorder Output Scale Minimum - roPL

This parameter defines the minimum scale value of the Recorder Output (Terminals 10 and 11) and may be adjusted over the range -1999 to 9999. The decimal point position for the Recorder Output scaling always corresponds to that for the process variable input range. If the Recorder Output Scale Minimum is adjusted to be greater than the Recorder Output Scale Maximum, the relationship between the process variable value and the Recorder Output is inverted. Example: For a 0 - 5V recorder output, this value corresponds to 0V output.

### 4.3.12 Output 1 Power Limit - OPhi

This is used to limit the power level of Output 1 and may be used to protect the process. If no protection is required, this parameter may be set to 100%. This parameter is omitted if Proportional Band = 0%.

### 4.3.13 Output 1 Cycle Time - Ct1

The selection of cycle times is dependent upon the process being controlled. For relay outputs, the cycle time should be as large as possible (consistent with satisfactory control) in order to maximise relay life. If the SSR Drive Output is fitted, the cycle time may be selected from the lower values in the permitted range. The permitted range of values is:

1/2, 1, 2, 4, 8, 16, 32 and 64 seconds

This parameter is omitted from the Set-Up sequence if Proportional Band = 0%.

### 4.3.14 Output 2 Cycle Time - Ct2

The value of this parameter can be set in the range:

1/2, 1, 2, 4, 8, 16, 32, 64, 128, 256 and 512 seconds

This parameter is omitted if Proportional Band **Pb** = 0%, if **rCG** >1 or if Output 2 is not fitted.

### 4.3.15 Output 2 Value - Out2

This parameter defines the switch-on and switch-off levels for Output 2 operating in ON/OFF Mode. The levels are defined as follows (for a direct- acting Output 2):

Switch-on: Set Point + Output 2 Value + 1/2 x On/Off differential.

Switch-off: Set Point + Output 2 Value - 1/2 x On/Off differential.

Note that the Output 2 Value may be negative, in which case the expressions above are still valid but Output 2 will switch on when the process variable is below the set point.

### 4.3.16 Process Alarm Value - P_AL

This sets the level of the process variable at which the process alarm will operate (see Subsection 4.6). This parameter will be omitted from the Set-Up sequence if the process alarm option is not fitted.

### 4.3.17 Band Alarm Value - b_AL

This sets the level of the process variable deviation at which the band alarm will operate (see Subsection 4.6). This parameter will be omitted from the Set- Up sequence if the band alarm option is not fitted.

### 4.3.18 Deviation Alarm Value - d_AL

This sets the level of the process variable deviation at which the deviation alarm will operate (see Subsection 4.6). This parameter will be omitted from the Set-Up sequence if the deviation alarm option is not fitted.

### 4.3.19 Scale Range Decimal Point - rPnt

This parameter defines the position of the decimal point on the measured variable and the set point. The default value is 1. This parameter is omitted from the Set-Up sequence if the Linear Input Option is not fitted.

### 4.3.20 Scale Range Maximum and Scale Range Minimum - rhi & rLo

These parameters define the maximum and minimum values to which the set point may be adjusted. The permitted range of these parameters is dependent upon the value of the Scale Range Decimal Position (**rPnt**). The default values are 100.0 (for **rhi**) and 000.0 (for **rLo**). These parameters are omitted from the Set-Up sequence if the Linear Input Option is not fitted.

### 4.3.21 Motor Travel Time - tr

**NOTE**

This parameter is only applicable to Controllers with VMD Open Loop Output.

This parameter must be set to the time taken for the motor to turn the valve from "completely open" to "completely closed" or vice versa. It can be adjusted within the range five seconds to five minutes. The default value is one minute.

### 4.3.22 Motor Switching Hysteresis - hYSt

**NOTE**

This parameter is only applicable to Controllers with VMD Open Loop Output.

This parameter defines the minimum amount of motor travel (expressed as a percentage of the total motor travel) which the VMD Open Loop output can cause. This enables minor fluctuations in the control or process conditions to be ignored, eliminating "fluttering" in the valve motor. This parameter can be adjusted within the range 0.04% to 5% of full travel. The default value is 1%.

### 4.3.23 Manual Control Enable/Disable - EnbL

This parameter determines whether Manual Control is enabled or disabled. Default setting is 0 (disabled).

**Table 4-1 Controller Function Ranges/Default Values**

| Parameter | Legend | Range | Default Value |
|---|---|---|---|
| Set Point | SP | Between SP High Limit and SP Low Limit | Range Minimum |
| Output Power [6] | OP | -100% to +100% (Adjustable in Manual Control). Not applicable for VMD Output. | Read Only |
| Proportional Band | Pb | 0% to 1000% of span (1% to 1000% for VMD Output) | 10% |
| Integral Time Constant[1] | rSEt | 10 secs. - 30 mins. and OFF (VMD Output: 10 secs. - 99 mins. 59 secs. - no OFF setting available) | 5 mins. 00 secs. |
| Derivative Time Constant[1] | rAtE | 00 secs. - 10 mins. | 30 secs. (Standard)<br>00 secs. (VMD Output) |
| Relative Gain[1, 8] | rCG | 0.02 - 1.00 and ON/OFF (>1.00) | 1.00 |
| Overlap/Deadband[1, 8] | OL | -20% to +20% of Proportional Band | 0% |
| On/Off Differential[2] | | | |
| OP 1 Only | diF1 | 0.1% to 10% of span of Controller | - |
| OP 2 Only [8] | diF2 | | |
| OP 1 & OP2 [8] | diFF | | |
| Set Point High Limit | SPHi | Set Point to Range Maximum | Range Maximum |
| Set Point Low Limit | SPLo | Range Minimum to Set Point | Range Minimum |
| Recorder Output Scale Maximum | roPH | -1999 to 9999 | Range Maximum |
| Recorder Output Scale Minimum | roPL | -1999 to 9999 | Range Minimum |
| Output 1 Power Limit[1] | OPHi | 0% to 100% of full power | 100%; not available if VMD Option is fitted |

*Table 4-1 (Cont.) Ranges & Default Values*

| Parameter | Legend | Range | Default Value |
|---|---|---|---|
| Output 1 Cycle Time[1] | Ct 1 | 0.5, 1, 2, 4, 8, 16, 32 or 64 seconds | 32 seconds |
| Output 2 Cycle Time[1, 8] | Ct2 | 0.5, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 seconds | 32 seconds |
| Output 2 Value[3, 8] | Out2 | ± span from Set Point | 0 |
| Process Alarm Value[4] | P_AL | Range Minimum to Range Maximum | Range Maximum |
| Band Alarm Value[4] | b_AL | 0 to span from Set Point | 5 units |
| Deviation Alarm Value[4] | d_AL | ±span from Set Point | 5 units |
| Scale Range Decimal Point[5] | rPnt | 0, 1, 2 or 3 | 1 |
| Scale Range Maximum[5] | rhi | (**rLo** + 1) to 9999 | 100.0 |
| Scale Range Minimum[5] | rLo | -1999 to (**rhi** -1) | 0.0 |
| Motor Travel Time[7] | tr | 5 seconds to 5 minutes in 1-second increments | 1 minute |
| Motor Switching Hysteresis[7] | hYSt | 0.04% to 5% of travel in 0.01% increments | 1% |
| Manual Control Enable/Disable | EnbL | 0 (Disabled) or 1 (Enabled) | 0 |

**NOTES ON TABLE 4-1**

1. These parameters are not operative or accessible if the Proportional Band (**Pb**) = 0%.
2. Switching differential with ON/OFF relay output.
3. Accessible only if Output 2 is fitted and is set to ON/OFF (Relative Gain (**rCG**) > 1.00).
4. These parameters are optional. Refer to Subsection 4.6 for details of alarm operation.
5. Only accessible if DC Linear Input is fitted.
6. 0% to 100% on Controllers with Output 1 only or with Output 2 set to ON/OFF (Relative Gain > 1.00) or to Event.
7. Controllers fitted with VMD Output only.
8. Not accessed if Output 2 is not fitted/enabled.

## 4.4 TUNING THE CONTROLLER

### 4.4.1 Controllers Fitted with Output 1 Only

**NOTE**

For Controllers fitted with VMD Open Loop Output, refer to Subsection 4.4.2.

Before starting to tune the controller to the load, check that:

- Output 1 Power Limit (**OPhi**) is set to the required level (see Subsection 4.3.12).

- Set Point Maximum (**SPhi**) and Set Point Minimum (**SPLo**) are set to safe levels (see Subsection 4.3.9).

- Cycle Times (**Ct1**, **Ct2**) are set to suitable values (see Subsections 4.3.13 and 4.3.14).

The following simple techniques may be used to determine values for proportional band (**Pb**), deriavtive (**rAtE**) and integral (**rSEt**).

**NOTE**

This technique is suitable only for processes which are not harmed by large fluctuations in the process variable. They provide an acceptable basis from which to start fine tuning for a wide range of processes. For additional information on tuning, including alternative tuning techniques, refer to the book "Principles of Temperature Control", available from WEST.

1. Set the Set Point (**SP**) to the normal operating process value (set it to a lower value if overshoot beyond the normal operating process value is likely to cause damage).

2. Set the Proportional Band (**Pb**) to 1%, the Integral Time Constant (**rSEt**) to Off (i.e increase the value of **rSEt** until the upper display goes blank) and the Derivative Time Constant (**rAtE**) to 0.

3. Follow the instructions in Figure 4-3. At each stage, allow sufficient time before moving on to the subsequent stage.

AFTER SETTING UP THE PARAMETERS, SET THE CONTROLLER TO USER MODE (SEE SUBSECTION 4.7) TO PREVENT UNAUTHORISED ADJUSTMENT TO THE VALUES.

### 4.4.2 Controllers with VMD Open Loop Output

Before starting to tune the controller to the load, check that the Set Point Maximum (**SPhi**) and Set Point Minimum (**SPLo**) are set to safe levels (see Subsection 4.3.9).

The tuning procedure is as follows:

1. Set the set point (**SP**) to below the normal operating process value (significantly lower if overshoot beyond this value is likely to cause damage).

2. Set the proportional band (**Pb**) to 1%, set the integral time constant (**rSEt**) to its maximum value (99 minutes 59 seconds) and set the derivative time constant (**rAtE**) to zero.

3. Set the motor travel time (**tr**) to the time required for the valve to travel from fully-open to fully-closed (or vice versa).

4. Set the motor switching hysteresis (**hYSt**) to the minimum motor travel required (expressed as a percentage of the full motor travel).

5. Follow the instructions shown in Figure 4-3, allowing sufficient time at each stage before performing the subsequent stage, with the exception that the derivative time constant (**rAtE**) should remain at zero for Controllers fitted with the VMD Output option.

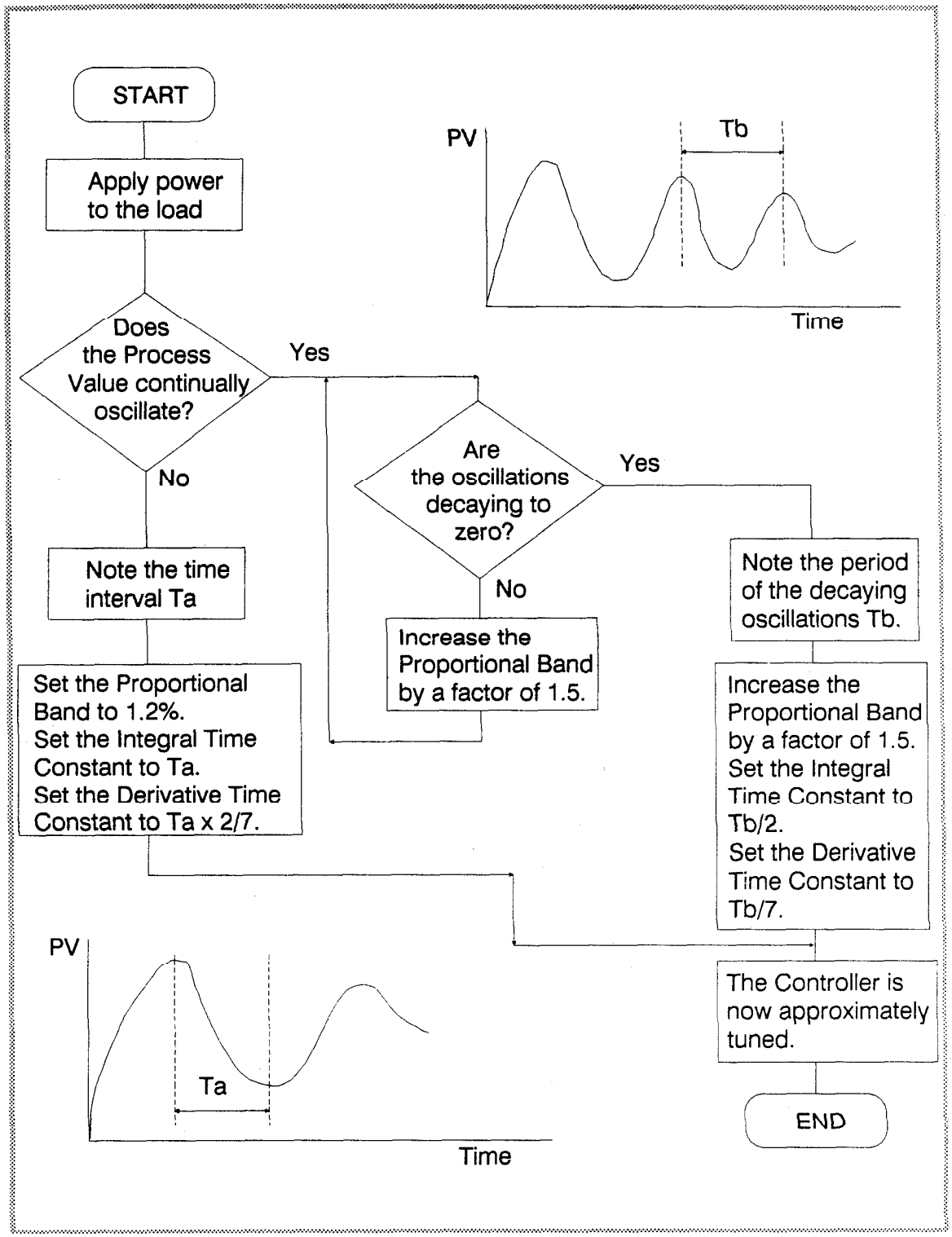

START
Apply power to the load
Does the Process Value continually oscillate?
Yes
No
Are the oscillations decaying to zero?
Yes
No
Note the time interval Ta
Set the Proportional Band to 1.2%.
Set the Integral Time Constant to Ta.
Set the Derivative Time Constant to Ta x 2/7.
Increase the Proportional Band by a factor of 1.5.
Note the period of the decaying oscillations Tb.
Increase the Proportional Band by a factor of 1.5.
Set the Integral Time Constant to Tb/2.
Set the Derivative Time Constant to Tb/7.
The Controller is now approximately tuned.
END
PV
Tb
Time
PV
Ta
Time

**Figure 4-3 Tuning (Output 1 Only or VMD Output)**

### 4.4.3 Controllers Fitted with Output 1 and Output 2

**NOTE**

Before starting to tune the Controller to the load, check that:

- Output 1 Power Limit (**OPhi**) is set to the required level (see Subsection 4.3.12).

- Set Point Minimum (**SPLo**) and Set Point Maximum (**SPhi**) are set to safe levels (see Subsection 4.3.9).

- Cycle Times (**Ct1, Ct2**) are set to suitable values (see Subsections 4.3.13 and 4.3.14).

In addition to the proportional band, integral and derivative, two more control parameters are provided in the Set-Up sequence:

(a) Relative Gain (**rCG**)

(b) Deadband/Overlap (**OL**)

The relationship between these parameters and the Controller output is illustrated in Figure 4-2.

1. Set the overlap to 0.

2. Set the relative gain to 1.00.

3. With power connected to the heater, but with the machine not running, perform the tuning method described in Subsection 4.4.1.

4. Start the machine and observe the oscillation (if any) of the process variable about the set point.

5. Follow the instructions in Figure 4-4.

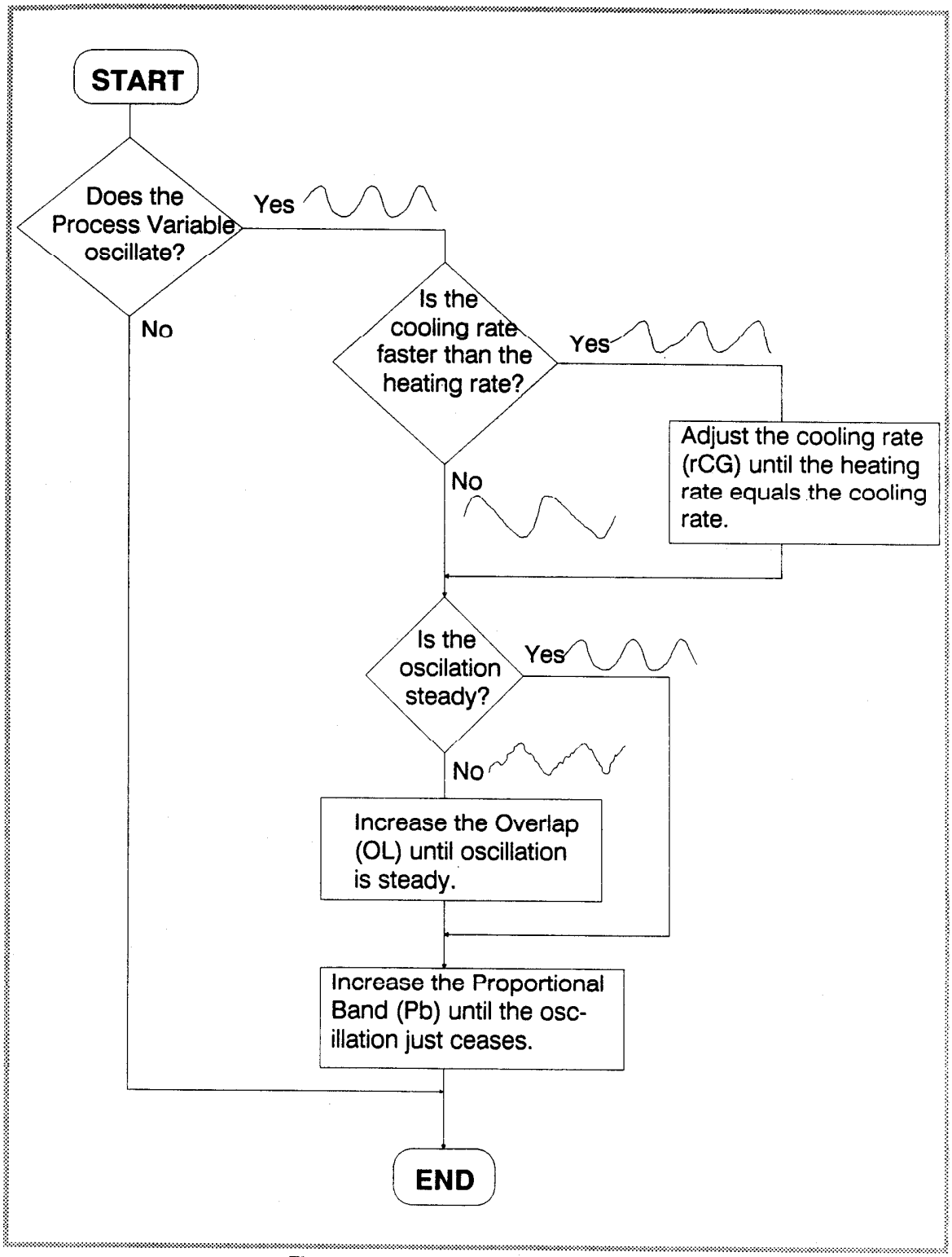

START
Does the Process Variable oscillate?
Yes
No
Is the cooling rate faster than the heating rate?
Yes
No
Adjust the cooling rate (rCG) until the heating rate equals the cooling rate.
Is the oscilation steady?
Yes
No
Increase the Overlap (OL) until oscillation is steady.
Increase the Proportional Band (Pb) until the oscillation just ceases.
END

**Figure 4-4 Tuning - OP 1 & OP 2 Fitted**

## 4.5 PROGRAMMER FUNCTIONS

When the Programmer Functions are selected in Set Up Mode, the Controller initially displays (in the lower display) the legend:

GSh

This is the Guaranteed Soak Hysteresis and is the first in the Programmer Function display sequence. The upper display will show the value of this parameter. The full Programmer Function lower display sequence is as shown below. The upper display will show the value/setting in each case.

| Lower Display | Function | Upper Display | | Default |
|---|---|---|---|---|
| GSh | Guaranteed Soak Hysteresis | Value or blank | | Blank |
| trAC | Track and Hold | YES | no | no |
| b960 | x60 Operation | YES | no | no |
| OP2 | Output 2 or Event Output | EVnt | COOL | COOL |
| rMP | Ramp Programming Method | rAtE | tME | rAtE |
| inSP | Initial Set Point Selection | i=SP | i=Pu | i=SP |
| PrFL | Power Fail Strategy | Abrt | Cont | Abrt |
| SPCh | Dwell Set Point Change Permission | YES | no | YES |
| tYPE | Dwell Set Point Change Strategy | inSt | rMP | rMP |
| CoMM | Communications Type Selection | Std | MSt | Std |

### 4.5.1 Guaranteed Soak Hysteresis - GSH

This defines the maximum deviation (between Process Variable and Set Point) which will allow dwell timing to start. If the deviation exceeds this value, the start of dwell timing will be suspended in order to allow time for the Process Variable to come closer to the Set Point. Whilst the dwell timing is suspended, the lower display will flash (in normal display mode). When the deviation becomes less than the Guaranteed Soak Hysteresis, the dwell timing is started. If the Guaranteed Soak Hysteresis is set to a value equal to the span of the Controller (e.g. if a DC Linear Input is fitted, Scale Range Maximum - Scale Range Minimum), the upper display goes blank and this facility is inoperative (OFF). *Note that, once dwell timing is started, it will not be affected by any deviation outside the Guaranteed Soak Hysteresis band.*

### 4.5.2 Track and Hold Selection - trAC

When the Track and Hold facility is selected, if the Process Variable and the Set Point differ by more than the value of the Guaranteed Soak Hysteresis parameter during a ramp or dwell period, the ramp/dwell timing is suspended until the deviation is less than the Guaranteed Soak Hysteresis. Whilst the timing is suspended, the lower display will flash (in normal display mode). When the deviation becomes less than the Guaranteed Soak Hysteresis, the timing is resumed. This parameter can be set to **YES** (ON) or **no** (OFF). This parameter is included in the display sequence only if the Guaranteed Soak Hysteresis is set ON. *Note that the Track and Hold facility, when ON, is active at all times i.e. whenever the deviation exceeds the Guaranteed Soak Hysteresis, the timing (during a ramp or dwell) is suspended.*

The operation of the Guaranteed Soak Hysteresis and Track and Hold parameters is illustrated in Figure 4-5.

### 4.5.3 x60 Operation - bY60

This facility, when selected, alters the timescales for ramp and dwell periods from the normal "units/hour" or "hours:minutes" to "units/minute" or "minutes:seconds" i.e. timescales are shortened by a factor of 60. This parameter can be set to **YES** (ON) or **no** (OFF).

### 4.5.4 Output 2 or Event Output Configuration - OP2

This parameter permits the output to be allocated either as Cool or as an Event Output (Event Output is applicable only if the Output 2 relay hardware is fitted).

### 4.5.5 Ramp Programming Method - rMP

This parameter defines the method by which ramps may be defined:

**Rate:** The ramp is defined by a final value (**FSP1** or **FSP2**) and a ramp rate (**rtr1** or **rtr2**), normally in units/hour.

**Time:** The ramp is defined by a final value (**FSP1** or **FSP2**) and a time (duration) for the ramp (**tr1** or **tr2**), normally in hours.

This parameter may be set to **rAtE** (Rate) or **tME** (Time).

## NOTE

If the setting of this parameter is changed, the profile data parameter for the new setting (ramp rate or ramp time) is set to its default value.

### 4.5.6 Initial Set Point Selection - inSP

This defines the profile starting set point value to be either the current Controller set point (**i = SP**) or the current process variable value (**i = Pv**).

### 4.5.7 Power Fail Strategy - PrFL

This parameter defines the response to restoration of power after a power failure during the running of the profile:

**Abrt:** When power is restored, the profile is aborted. The upper display will show the process variable value and the lower display will show the legend **Abrt**. When the profile is run again, it will start from the beginning of Ramp 1.

**Cont:** When power is restored, the profile will continue from the point reached at the instant of power failure.

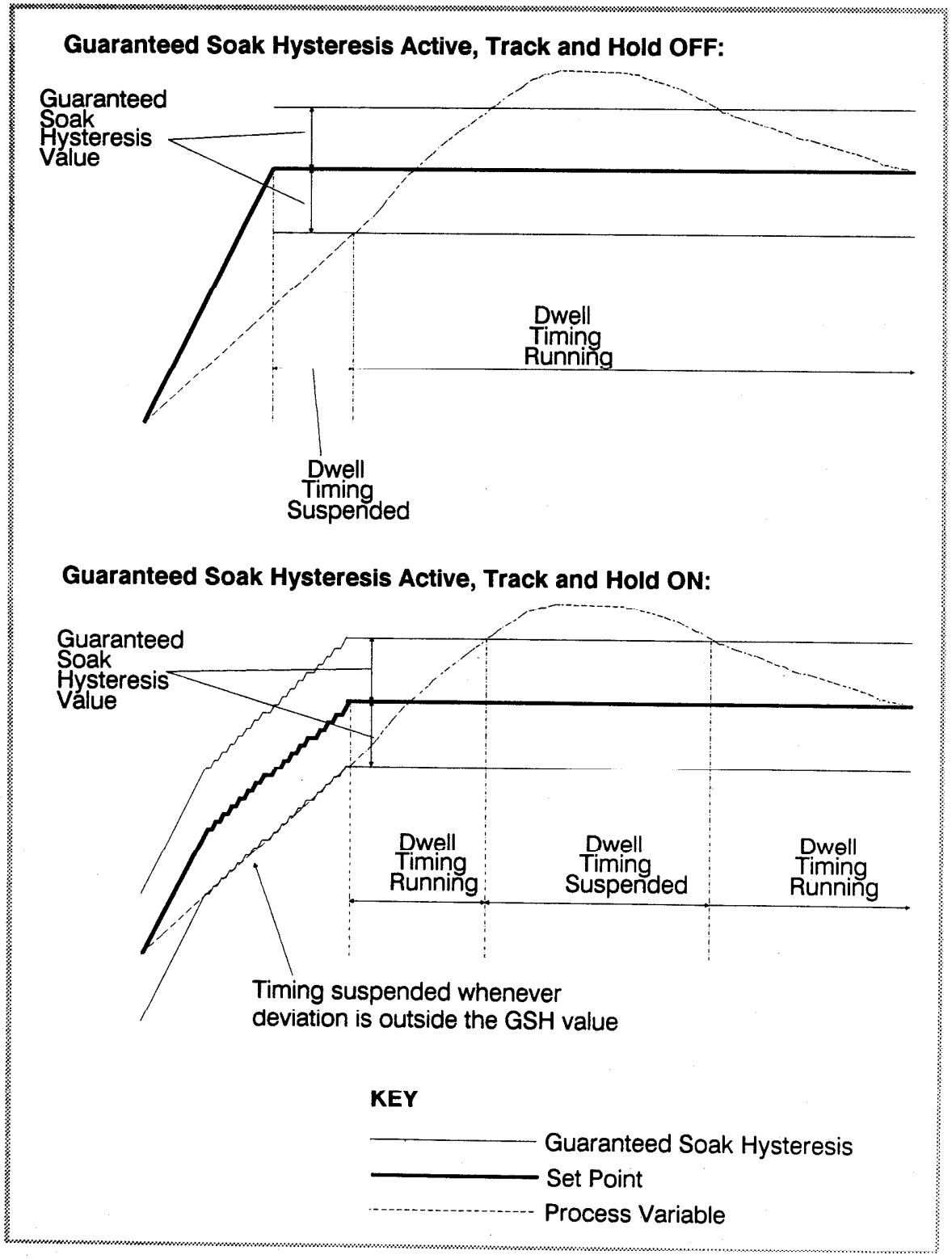

Guaranteed Soak Hysteresis Active, Track and Hold OFF:
Guaranteed Soak Hysteresis Value
Dwell Timing Running
Dwell Timing Suspended
Guaranteed Soak Hysteresis Active, Track and Hold ON:
Guaranteed Soak Hysteresis Value
Dwell Timing Running
Dwell Timing Suspended
Dwell Timing Running
Timing suspended whenever deviation is outside the GSH value
KEY
Guaranteed Soak Hysteresis
Set Point
Process Variable

**Figure 4-5 Guaranteed Soak Hysteresis/Track and Hold**

### 4.5.8 Dwell Set Point Change Permission - SPCh

This parameter allows or inhibits the alteration of the dwell set points during the running of the profile:

**YES**: Changes permitted.

**no**: Changes inhibited.

### 4.5.9 Dwell Set Point Change Strategy - tYPE

This parameter defines the response to a change in dwell set point value whilst the profile is running (if this is permitted by Dwell Set Point Change Permission - see Subsection 4.5.8). This parameter may be set to **inSt** (instantaneous change) or **rMP** (ramp to new value). The operation of this parameter is explained in Figure 4-6. This parameter appears only if the Ramp Programming Method is set to **Rate**.

### 4.5.10 Communications Type Selection - CoM

This parameter defines whether the Controller acts as a Slave device (Product Code X06) or as a Master device (Product Code X82) for controlling up to 32 slave controllers. When the Controller operates as a Master device, the current set point value is output to all 32 slave controllers and is updated to all controllers every four seconds. The two possible settings are **Std** (standard Slave configuration) and **MSt** (Master configuration).

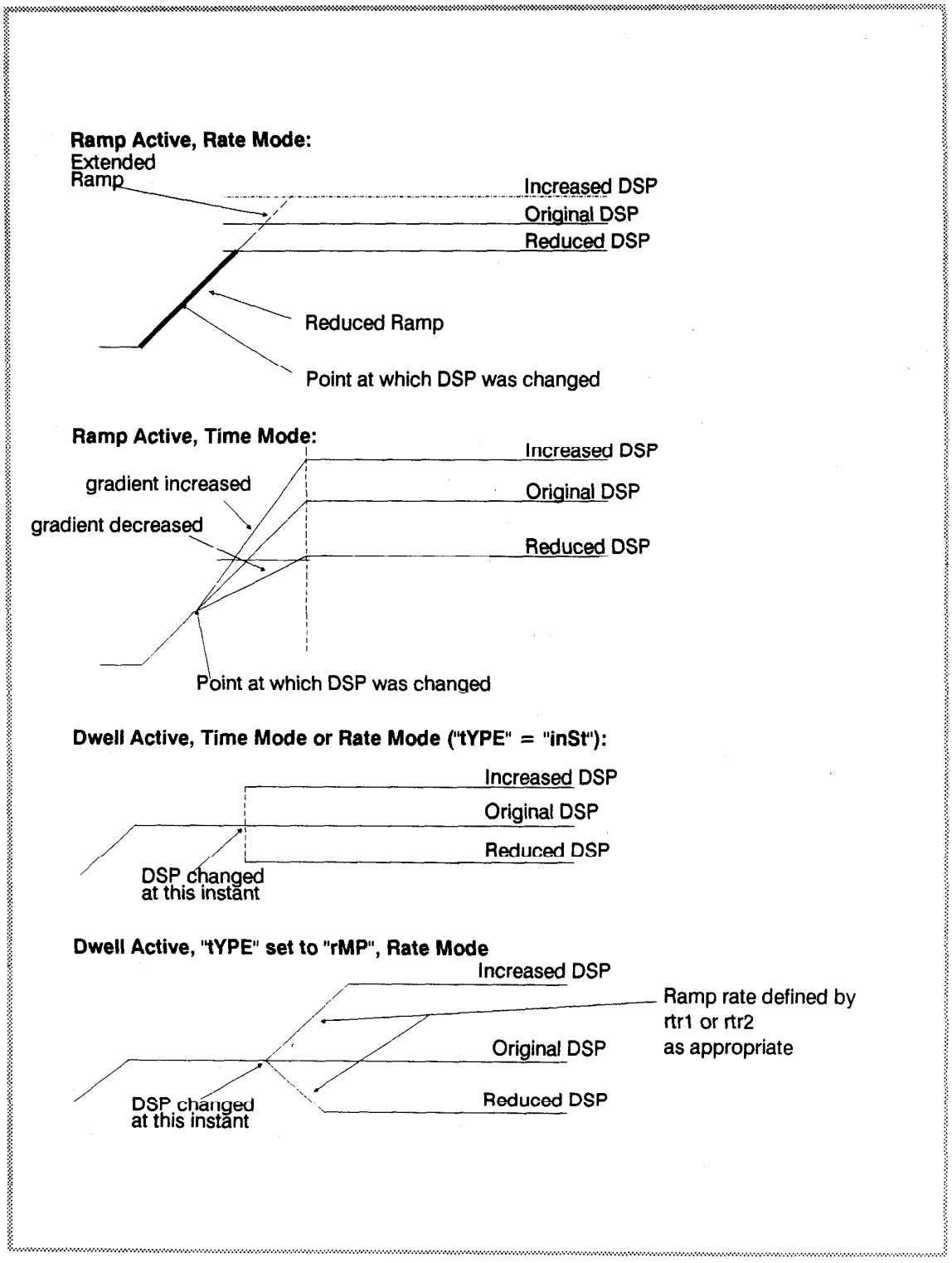



**Figure 4-6 Dwell Set Point Change Strategy**

## 4.6 ALARMS

Six possible configurations of alarm are available:

| Product Code | Type | Action |
|---|---|---|
| C--46 | Band Alarm | Relay ON inside band |
| C--47 | Band Alarm | Relay ON outside band |
| C--48 | Process Alarm | Direct |
| C--49 | Process Alarm | Reverse |
| C--50 | Deviation Alarm | Direct |
| C--51 | Deviation Alarm | Reverse |

Product codes C--46, C--47, C--50 and C--51 refer to deviation alarms. Product codes C--48 and C--49 refer to alarms with a value which is absolute i.e. not relative to the set point. For confgurations C--50 and C--51, the value may be set positive or negative.

The operation of the various alarm types is shown in Figure 4-7.

## 4.7 LEAVING SET UP MODE

### NOTE

When the Controller is in Set Up Mode, if more than one minute elapses without any pushbutton being depressed, the Controller will return automatically to the User Mode. Therefore, the following procedure is required only if it is necessary to leave Set Up Mode immediately.

To return the Controller to User Mode:

1. Using the **FUNC** pushbutton, select display of any of the three Set Up Mode header displays in the upper display.

2. Simultaneously depress and hold the Raise and Lower pushbuttons until the **SET** indicator starts to flash.

3. Within three seconds of the **SET** indicator starting to flash, release the Raise and Lower pushbuttons and depress and hold the **FUNC** pushbutton until the **SET** indicator is extinguished.

The Controller is now in User Mode.

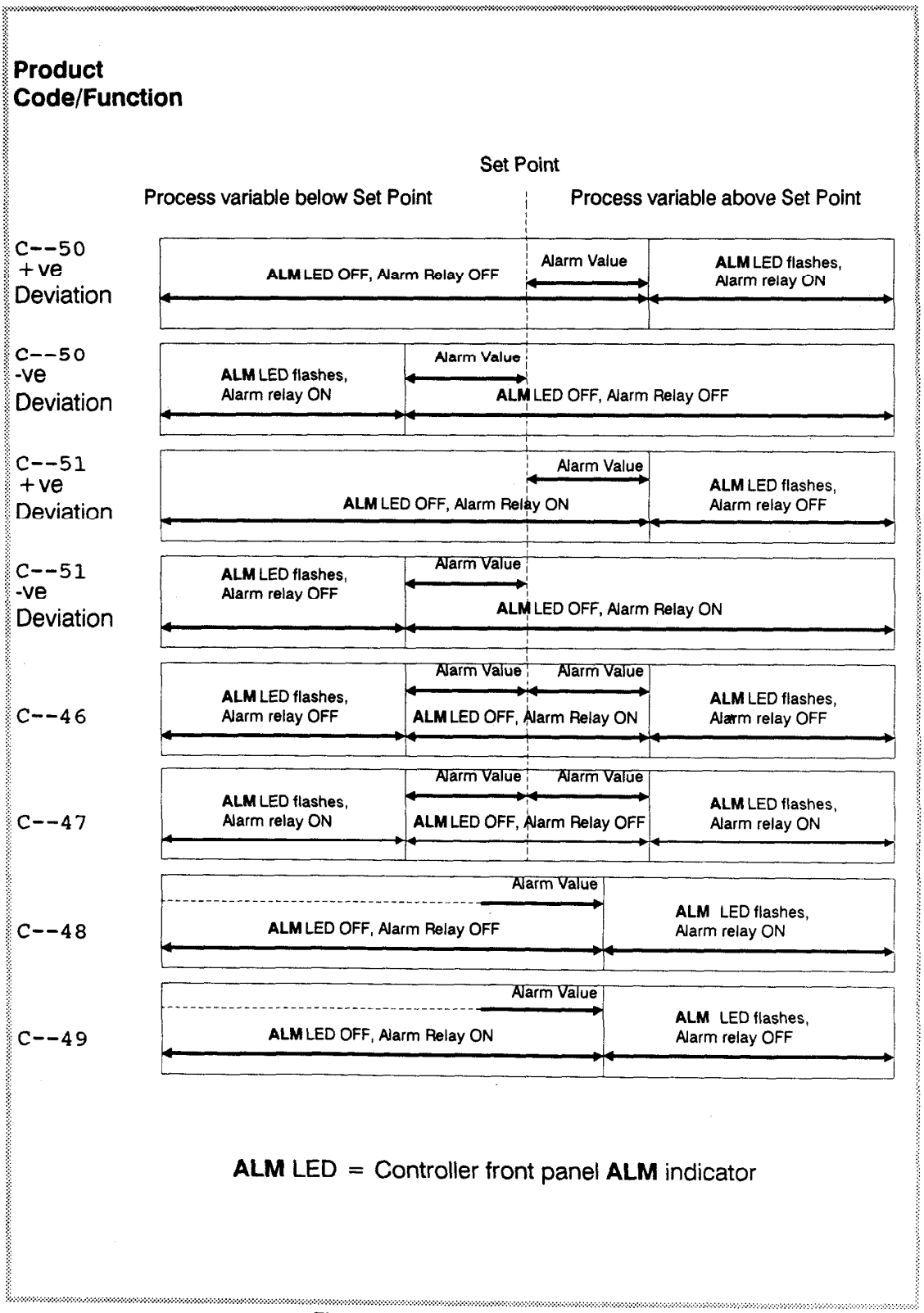

Product Code/Function
Set Point
Process variable below Set Point
Process variable above Set Point
C--50 +ve Deviation
ALM LED OFF, Alarm Relay OFF
Alarm Value
ALM LED flashes, Alarm relay ON
C--50 -ve Deviation
ALM LED flashes, Alarm relay ON
Alarm Value
ALM LED OFF, Alarm Relay OFF
C--51 +ve Deviation
Alarm Value
ALM LED OFF, Alarm Relay ON
ALM LED flashes, Alarm relay OFF
C--51 -ve Deviation
ALM LED flashes, Alarm relay OFF
Alarm Value
ALM LED OFF, Alarm Relay ON
C--46
Alarm Value
Alarm Value
ALM LED flashes, Alarm relay OFF
ALM LED OFF, Alarm Relay ON
ALM LED flashes, Alarm relay OFF
C--47
Alarm Value
Alarm Value
ALM LED flashes, Alarm relay ON
ALM LED OFF, Alarm Relay OFF
ALM LED flashes, Alarm relay ON
C--48
Alarm Value
ALM LED OFF, Alarm Relay OFF
ALM LED flashes, Alarm relay ON
C--49
Alarm Value
ALM LED OFF, Alarm Relay ON
ALM LED flashes, Alarm relay OFF
ALM LED = Controller front panel ALM indicator

**Figure 4-7 Operation of Alarms**

# SECTION 5
# OPERATION VIA AN RS485-COMPATIBLE SERIAL COMMUNICATIONS LINK

**NOTE**

The Communications Link is *not* available on Controllers which are fitted with either (a) the Recorder Output Option or (b) the Alarm relay output with *either* Output 2 or the Event Output.

The WEST Model 3750 Controller may be fitted with the facility for serial communication via an RS485-compatible serial link.

## 5.1 RS485 CONNECTIONS

Controllers which are equipped with the RS485 Option use Terminals 10, 11 and 12, as described in Subsection 2.7.9 and Figure 2-19. Communication is at 4800 Baud and the cable used should be suitable for data transfer at this frequency and for the distance required. The transmitters and receivers in the Controller conform to recommendations contained in EIA Standard RS485. Up to 32 Controllers may be connected in parallel with one master device.

## 5.2 ACTIVATING THE COMMUNICATIONS LINK (CONTROLLER OPERATING AS SLAVE)

For the Controller to operate as a slave, the **CoM** Programmer Function must be set to **Std** (see Subsection 4.5). The two variants of Option Board which provide the RS485 Option are shown in Figures 5-1 (Option Board Type 481) and 5-2 (Option Board Type 489). These illustrations show the location of the on-board DIL switches and the link jumper positions. With switch S6 be set ON, the Controller parameters may be adjusted by the master device via the RS485 communication channel. When switch S6 is set OFF, the Controller will not adjust or change any of its parameters in response to commands received via the RS485 channel. With switch S6 in either position, the Controller will return the requested information in response to an interrogation message (see Subsection 5.4.3) from the master device.

## 5.3 RS485 CHANNEL SELECTION (CONTROLLER OPERATING AS SLAVE)

For the Controller to operate as a slave, the **CoM** Programmer Function must be set to **Std** (see Subsection 4.5). Each slave Controller connected to a master device has assigned to it a unique channel address which enables the master to communicate with each slave Controller individually. The channel address is defined by the setting of switches S1 - S5 on the Option Board, thus providing up to 32 possible channel addresses for each master device. The channel addresses are defined in Table 5-1.

## 5.4 OPERATING THE CONTROLLER AS A MASTER DEVICE

To operate the Controller as a master device, the **CoM** Programmer Function must be set to **MSt** (see Subsection 4.5). The only other requirement is to observe the data format and communications protocol described in later subsections.

## 5.5 RS485 OPERATION

### 5.5.1 Character Transmission

Data characters transmitted comprise one start bit, seven data bits, one parity bit (even) and a stop bit. The link is asynchronous and operates at a transfer rate of 4800 Baud.

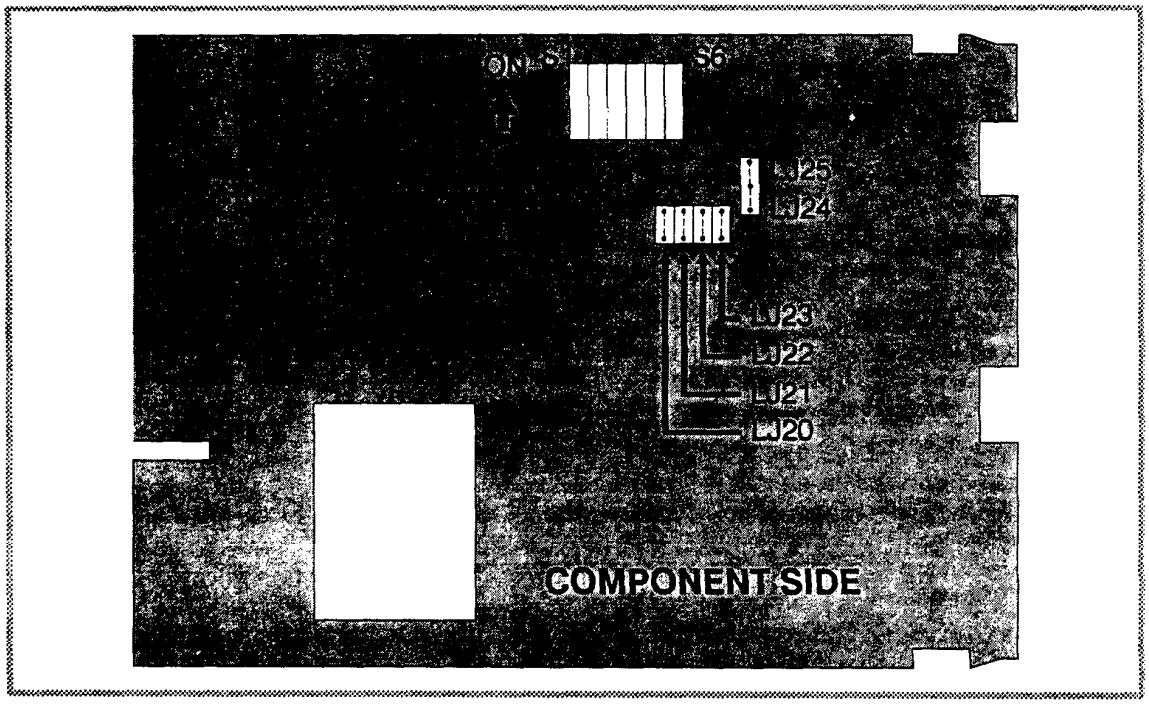



**Figure 5-1 Option Board Type 481 - RS485 Switches**

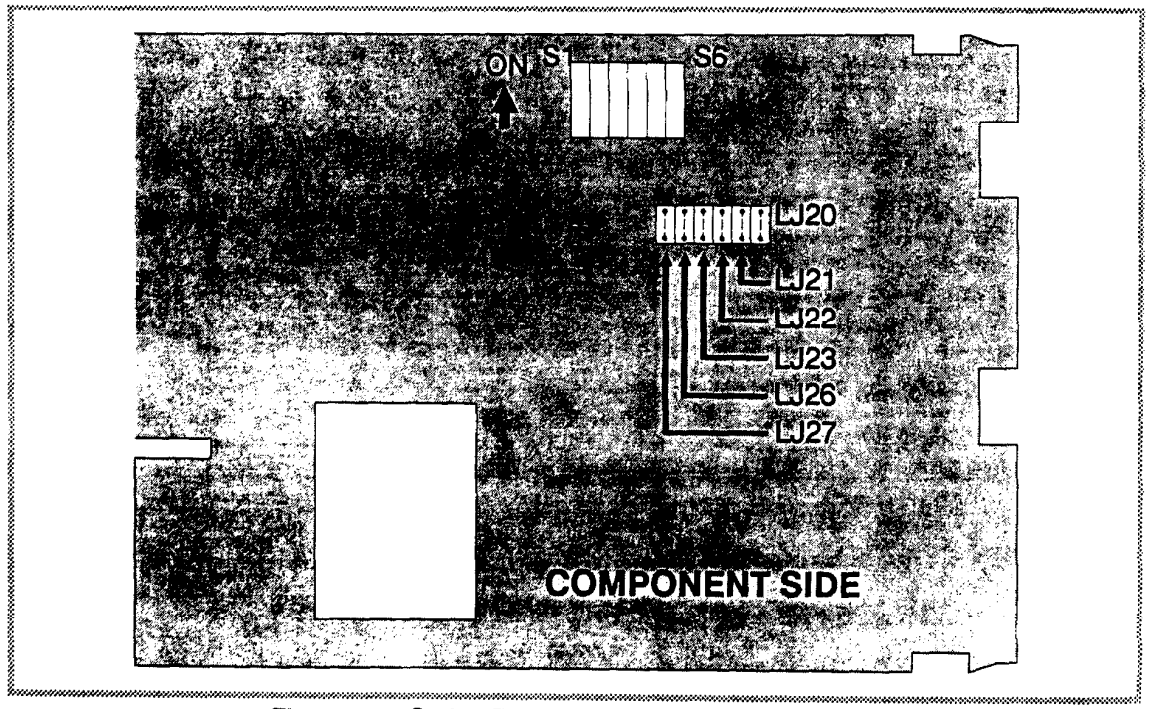



**Figure 5-2 Option Board Type 489 - RS485 Switches**

**Table 5-1 RS485 Channel Selection**

| | Switch | | | | | | Switch | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Channel No. | S5 | S4 | S3 | S2 | S1 | Channel No. | S5 | S4 | S3 | S2 | S1 |
| 1 | - | - | - | - | X | 17 | X | - | - | - | X |
| 2 | - | - | - | X | - | 18 | X | - | - | X | - |
| 3 | - | - | - | X | X | 19 | X | - | - | X | X |
| 4 | - | - | X | - | - | 20 | X | - | X | - | - |
| 5 | - | - | X | - | X | 21 | X | - | X | - | X |
| 6 | - | - | X | X | - | 22 | X | - | X | X | - |
| 7 | - | - | X | X | X | 23 | X | - | X | X | X |
| 8 | - | X | - | - | - | 24 | X | X | - | - | - |
| 9 | - | X | - | - | X | 25 | X | X | - | - | X |
| 10 | - | X | - | X | - | 26 | X | X | - | X | - |
| 11 | - | X | - | X | X | 27 | X | X | - | X | X |
| 12 | - | X | X | - | - | 28 | X | X | X | - | - |
| 13 | - | X | X | - | X | 29 | X | X | X | - | X |
| 14 | - | X | X | X | - | 30 | X | X | X | X | - |
| 15 | - | X | X | X | X | 31 | X | X | X | X | X |
| 16 | X | - | - | - | - | 32 | - | - | - | - | - |

### 5.5.2 Line Turn-Round

RS485 circuits are a multi-drop half duplex system. When a device is transmitting, it drives the transmission lines to the appropriate levels; when it is not transmitting, its outputs are set to a high impedance in order that another device can transmit. It is important that a transmitter releases the transmission lines before another device starts transmission. This imposes the following restraints on a computer system communicating with the Controller(s):

(a) The transmitter must release the transmission lines within 6 milliseconds of the end of the last character of a message being transmitted. Note that delays due to buffers such as those used in universal asynchronous receivers/transmitters (UARTs) within the computer must be taken into account.

(b) The transmitter must not start transmission until at least 6 milliseconds have elapsed since the reception of the last character of a message.

All WEST Controllers which have an RS485 communications facility adhere to this standard; thus, provided that the master device conforms similarly to the standard, there should be no line contention problems.

### 5.5.3 Communications Protocol

All communication is initiated by the master device. The master sends a command or query to the addressed slave and the slave replies with an acknowledgement of the command or the reply to the query. All messages, in either direction, comprise:

(a) a Start of Message character

(b) one or two address characters (defining the slave)

(c) a parameter/data string, and

(d) an End of Message character

Messages from the master may be one of four types:

**Type 1:** L {N} ? ? *

**Type 2:** L {N} {P} {C} *
or
R {N} {P} {C} *

**Type 3:** L {N} {P} # {data} *
or
R {N} {P} # {data} *

**Type 4:** L {N} {P} I *
or
R {N} {P} I *

where all characters are in ASCII code and:

| | |
|---|---|
| L or R | is the Start Character (Hex 4C or 52) |
| {N} | is the slave controller address in the range 1 - 32; addresses 1 - 9 may be represented as a single digit (e.g. 7) or in two-digit form, the first digit being a leading zero (e.g. 07). |
| {P} | is the parameter to be interrogated or modified (Hex 41 - 5D) - see Tables 5-2 and 5-3. |
| {C} | is the command (see below). |
| # | indicates that {data} is to follow. (Hex 23). |
| {data} | is a numeric data string in ASCII code (see Table 5-5) |
| * | is the End Character (Hex 2A). |

No spaces are permitted in messages.

**Type 1 Message**

L {N} ? ? *

This is used by the master device to determine whether a slave controller is active. The reply from the addressed controller, if it is active, is:

L {N} ? A *

An inactive controller will give no reply.

**Type 2 Message**

L {N} {P} {C} * or R {N} {P} {C} *

This is used by the master device to interrogate or modify a parameter in the addressed controller. {P} is the parameter as defined in Table 5-2 or Table 5-3 and {C} is the command, which may be one of the following:

| | |
|---|---|
| + (Hex 2B) | to increment the value of the parameter defined by {P} |
| - (Hex 2D) | to decrement the value of the parameter defined by {P} |
| ? (Hex 3F) | to determine the current value of the parameter defined by {P} |

The reply from the addressed controller is of the form:

L {N} {P} {data} A * or R {N} {P} {data} *

where {data} is five ASCII-coded digits whose format is shown in Table 5-5. The data is either the value requested in the query or the new parameter value after modification. If the value specified is not valid, because it is outside the permitted value range of that parameter or because the parameter is not modifiable, the controller replies with a negative acknowledgement:

L {N} {P} {data} N *

The {data} string in the reply is the current (unchanged) value of the specified parameter. If the process variable or the deviation is interrogated when the process variable is outside the range of the controller, the reply is:

L {N} {P} < ? ? > 0 A * if over-range

or

L {N} {P} < ? ? > 5 A * if under-range

A parameter character ] in the message from the master device indicates that a "combo-scan" is required; this provides a facility for interrogating the values of set point, process variable, power output(s) and status in a single message from the master device. The reply to such a command would be in the form:

L {N} ] xx aaaaa bbbbb ccccc ddddd eeeee A *

where xx indicates the number of data digits to follow; this is 20 for an "Output 1 Only" controller and 25 for an "Output 1 and Output 2" controller. The data digits are expressed as shown in Table 5-5 and may comprise:

| | |
|---|---|
| aaaaa | the current value of the set point |
| bbbbb | the current value of the process variable |
| ccccc | the current value of Output 1 power (0 - 100%) |
| ddddd | the current value of Output 2 power, if applicable (0 - 100%) |
| eeeee | the controller status as described in Table 5-2. |

**Type 3 Message**

L {N} {P} # {data} * or R {N} {P} # {data} *

This message type is used by the master to set a parameter to the value specified in {data}. The command is not immediately implemented by the slave; the slave will receive this command and will then wait for a Type 4 message. Upon receipt of a Type 3 message, if the {data} content and the specified parameter are valid, the slave controller replies with:

L {N} {P} {data} I * or R {N} {P} {data} I *

indicating that the controller is ready to implement the command. If the parameter character {P} is not alphabetic, the command is ignored. If the parameter specified is invalid or is not modifiable or if the desired value is outside the permitted range for that parameter, the controller replies with a negative acknowledgement:

L {N} {P} {data} N * or R {N} {P} {data} N *

**Type 4 Message**

L {N} {P} I * or R {N} {P} I *

This is sent by the master to the addressed controller following a successful Type 3 message transmission and reply to/from the same controller. Provided that the {data} content and the parameter specified in the preceding Type 3 message are still valid, the controller will then set the parameter to the desired value and will reply with:

L {N} {P} {data} A * or R {N} {P} {data} A *

where {data} is the new value of the parameter. If the new value or parameter specified is invalid, the controller will replay with a negative acknowledgement:

L {N} {P} {data} N * or R {N} {P} {data} N *

where {data} is the current (unaltered) value of the parameter. If the immediately-preceding message received by the controller was not a Type 3 message, the Type 4 message is ignored.

*A leaflet giving further details of software requirements and suggestions for programs to be implemented on the master is available on request from your nearest West Division.*

**Table 5-2 Parameters (Start Character = L)**

| Parameter Identifier | Parameter | Modifiable? |
|---|---|---|
| A | Set Point Maximum | Yes |
| B* | Output 1 Power Limit | Yes |
| C | Alarm Value | Yes |
| D | Derivative Time Constant | Yes |
| E* | On/Off Output 2 Value | Yes |
| F* | On/Off Differential | Yes (for Output 1 and Output 2 - if fitted - if the Proportional Band is set to 0%; for Output 2 only if Relative Gain > 1.00 i.e. Output 2 is in On/Off Mode). |
| G | Scale Range Maximum | Yes, if linear input fitted |
| H | Scale Range Minimum | Yes, if linear input fitted |
| I | Integral Time Constant[1] | Yes |
| J | Not applicable | |
| K* | Overlap/Deadband | Yes |
| L | Controller Status[2] | No |
| M | Process Variable | No |
| N | Output 1 Cycle Time* | Yes |
| | Motor Travel Time** | Yes |
| O | Output 2 Cycle Time* | Yes |
| | Motor Hysteresis** | Yes |
| P | Proportional Band | Yes |
| Q | Range Decimal Point | Yes, if linear input fitted |
| R | Not applicable | |
| S | Set Point | Yes |
| T | Set Point Minimum | Yes |
| U* | Relative Gain[3] | Yes |
| V | Deviation[4] | No |
| W* | Output Power | Yes, if in Manual Mode |
| X and Y | Not applicable | |
| Z* | Controller Commands[5] | Yes |
| ] | "Combo Scan" | No |
| ^ | Not Applicable | |

## NOTES ON TABLE 5-2

* Not applicable to Controllers fitted with VMD Output.

** Applicable only to Controllers fitted with VMD Output.

1. To set the Integral Time Constant OFF using the Parameter Set command, the {data} field should be set to 00002.

2. The value of the status is transmitted as four decimal digits followed by 0. The four-digit number must be converted into binary form in which:

Bit 0 (the least significant bit) refers to the alarm (1 = safe; 0 = unsafe, alarm not fitted or alarm switched off).

Bit 1 is not used.

Bit 2 is not used.

Bit 3 will be set to 1 if any programmable parameter has been changed, by means other than the communications link, since the last time access was gained to the status word.

Bit 4 indicates whether alteration of the parameters via the RS485 link is enabled (1 = enabled, 0 = disabled).

Bits 5, 6 and 7 are not used.

3. To set Output 2 to ON/OFF Mode with DC or time-proportioned Output 1, the {data} field for the Relative Gain parameter should be set to 00002.

4. Deviation = (Process variable - Set Point).

5. Only Type 3 or Type 4 messages can be used with this parameter. For this type of message, the second least significant digit of the {data} field must be one of four numbers, the remaining digits being zeroes. The reply from the Controller will also contain this comand number. The Type 4 message does not include the command number but the reply to the Type 4 message contains the number of the command executed. These command numbers are:

| | |
|---|---|
| 0010 | Activate Manual Control |
| 0020 | Activate Automatic Control |

**Table 5-3 Parameters (Start Character = R)**

| Parameter Identifier | Parameter | Modifiable? |
|---|---|---|
| A | Stage Number of modification/review | Yes |
| B | Ramp Final Temperature | Yes [1] |
| C | Ramp rate/time duration of ramp | Yes [1] |
| D | State of Event Output in ramp [2] | Yes [1] |
| E | Dwell time duration | Yes [1, 7] |
| F | State of Event Output in dwell [2] | Yes [1] |
| G | Number of profile cycles [4] | Yes [1] |
| H | Number of profile cycles completed | No |
| I | Current segment number [5] | No |
| J | Not applicable | - |
| K | Programmer commands [3] | Yes |
| L | Programmer status [6] | No |
| M | Current set point value | No |
| N | Current Event Output status | No |
| O | Not applicable | - |
| P | Not applicable | - |
| Q | Not applicable | - |
| R | Not applicable | - |
| S | Not applicable | - |
| T | Not applicable | - |
| U | Not applicable | - |
| V | Guaranteed Soak Hysteresis value | Yes [8] |
| W | Not applicable | - |
| X | Not applicable | - |
| Y | Not applicable | - |
| Z | Not applicable | - |

## NOTES ON TABLE 5-3

1. These parameters are not modifiable whilst a profile is running.

2. Parameters D and F are used when an Event Output is fitted. To use these functions, the Stage Number must first be selected, using parameter A; then parameter(s) D and/or F must be accessed. If these parameters are interrogated (using a Type 2 message), {data} in the reply from the controller will be 00010 for ON or 00000 for OFF. The state can be changed by sending a Type 3/Type 4 message sequence with {data} set as required (00010 = ON, 00000 = OFF).

3. Programmer Commands: Profile control commands are available using Type 3 and Type 4 data set protocol only. Using Type 3 protocol, the third and fourth digits of the {data} field must be one of the numbers shown in Table 5-4, the rest of the {data} field being set to zero. The reply will also contain the command number. The type 4 message does not contain the command number, but the Controller will execute the command specified by the immediately-preceding Type 3 message and will reply, giving the number of the executed command.

Type 3 commands will be in the form **R {N} K # {data} ***

Type 3 replies will be in the form **R {N} K {data} I ***

Type 4 commands will be in the form **R {N} K I ***

Type 4 replies will be in the form **R {N} K {data} A ***

## NOTES ON TABLE 5-3 (Continued)

The {**data**} field will be 00xx0, where xx is the command number.

If RS485 control is disabled, negative acknowledgements will be sent.

Command 5 (Abort) will display **Abrt** on the controller if no parameters are being reviewed on the front panel at the time.

**4.** Setting "Number of Cycles" to zero using a Type 3 or Type 4 message sequence will set an infinite number of cycles. The same effect will be achieved if "Number of Cycles" is incremented to a value greater than 9999 using a Type 2 message sequence.

**5.** "Current Segment Number" will cause a zero reply if the profile is not running.

**6. Programmer Status:** Programmer status is encoded using binary weighting as shown below:

| Flag: | ISP = SP/PV | x60 | Track & Hold | Rate/Time | Guar. Soak Hyst. | Wait |
|---|---|---|---|---|---|---|
| Binary Weighting: | $2^{11}$ | $2^{9}$ | $2^{7}$ | $2^{5}$ | $2^{4}$ | $2^{3}$ |
| Decimal Weighting: | 2048 | 512 | 128 | 32 | 16 | 8 |
| Condition when set: | ISP = PV | Active | Active | Rate | Active | Waiting |

| Flag: | Run | Abort | Hold |
|---|---|---|---|
| Binary Weighting: | $2^{2}$ | $2^{1}$ | $2^{0}$ |
| Decimal Weighting: | 4 | 2 | 1 |
| Condition when set: | Running | Aborting | Holding |

The status data is transmitted by the Controller as four decimal digits followed by 0, the four decimal digits representing the sum of all the flags which are set. This number must be converted from decimal into binary in the master to interpret the eight status bits.

**7.** Dwell Time Duration may be set to infinity by using the Parameter Set command to set the value of this parameter to "99:60" i.e. the {data} field of the command should be set to 99602.

**8.** Guaranteed Soak Hysteresis may be set OFF by using the parameter set command to set this parameter to a value equal to the span of the Controller (e.g. if a DC Linear Input is fitted, Scale Range Maximum - Scale Range Minimum).

### Table 5-4 Programmer Command Numbers

| Command Number | Command Function |
|---|---|
| 01 | Run profile |
| 02 | Hold profile |
| 03 | Cancel Hold |
| 04 | Segment Advance (jump to next segment) |
| 05 | Abort profile |
| 06 | ISP = SP |
| 07 | ISP = PV |
| 10 | Track & Hold enable |
| 11 | Track & Hold disable |
| 12 | x60 enable |
| 13 | x60 disable |

### 5.5.4 Data Format

The {**data**} field contains five ASCII-coded decimal digits. The first four digits form a decimal number whose sign and magnitude are defined by the value of the fifth digit, as shown in Table 5-5.

**Table 5-5 {data} Field Format/Decimal Point Posn.**

| First Four Digits | Fifth Digit |
|---|---|
| +abcd | 0 |
| +abc.d | 1 |
| +ab.cd | 2 |
| +a.bcd | 3 |
| +a.b.c.d. | 4* |
| -abcd | 5 |
| -abc.d | 6 |
| -ab.cd | 7 |
| -a.bcd | 8 |
| -a.b.c.d. | 9* |

* These values indicate that default parameter values are being used.

# SECTION 6
# RANGE-CHANGING AND RE-CONFIGURATION

It is possible to change the range of an input or output and to re-configure the Model 3750 Controller by means of changing the positions of link jumpers on the CPU Board and (if fitted) the Options Board. In order to gain access to these link jumpers, it is necessary to dismantle the Controller.

**NOTE**

The range-changing and re-configuration operations described in this Section are confined to those which can be achieved by simply changing the positions of the appropriate link jumpers. It is not possible to change from one type of input to another or from one type of output to another, without changing the Boards.

## 6.1 DISMANTLING THE CONTROLLER

**CAUTION**

1. Before starting the dismantling procedure, ensure that the mains (line) supply has been disconnected.

2. The Controller contains devices which are vulnerable to damage from electrostatic discharge. In order to minimise the risk of such damage, certain precautions are recommended:

(a) Never touch the tracks or components (except for link jumpers) on the PCBs.
(b) Before handling a PCB, momentarily touch a convenient earthing point (e.g. a metal bench or rack) in order to discharge most of the static electricity stored.
(c) Wear a wrist earthing strap.

3. The Controller also contains a lithium battery on the CPU Board. When removing the CPU Board from the Controller, ensure that it is not placed on a conducting surface; such contact would short-circuit the battery. IF IT IS REQUIRED TO REPLACE THE BATTERY, THIS OPERATION SHOULD BE PERFORMED BY A TRAINED TECHNICIAN.

### 6.1.1 Withdrawing the Controller from its Housing

1. With an appropriate size screwdriver (5mm or 3/16-inch flat blade), rotate the locking screw at the bottom of the Controller front panel in an anti-clockwise direction to disengage the Controller back connectors from their sockets in the housing. Continue rotating the locking screw anti-clockwise until the screw is free from its bush in the Controller housing.

2. Gently withdraw the Controller from its housing.

### 6.1.2 Separating the PCBs (if an Options Board is Fitted)

If the Controller has an Options Board fitted, it will be necessary to separate the two PCBs (the CPU Board and the Options Board) in order to gain access to the link jumpers. This is achieved as follows:

1. Extract the screw securing the CPU Board (on the right-hand side as viewed from the front of the Controller) to the bracket attached to the Controller front panel assembly.

2. Grasp the guides projecting rearwards from the bottom of the front panel (see Figure 6-1) and pull them downwards until the bottom of the PCBs are released and can be withdrawn backwards; grasp the guides at the top of the front panel and disengage the top edges of the PCBs. The two PCBs may now be removed from the front panel assembly.

3. Extract the screw securing the Options Board to the pillar on the CPU Board. Carefully pull the two Boards apart, ensuring that the two Boards remain parallel to each other in order that the plugs and sockets linking the two Boards are not bent or distorted.

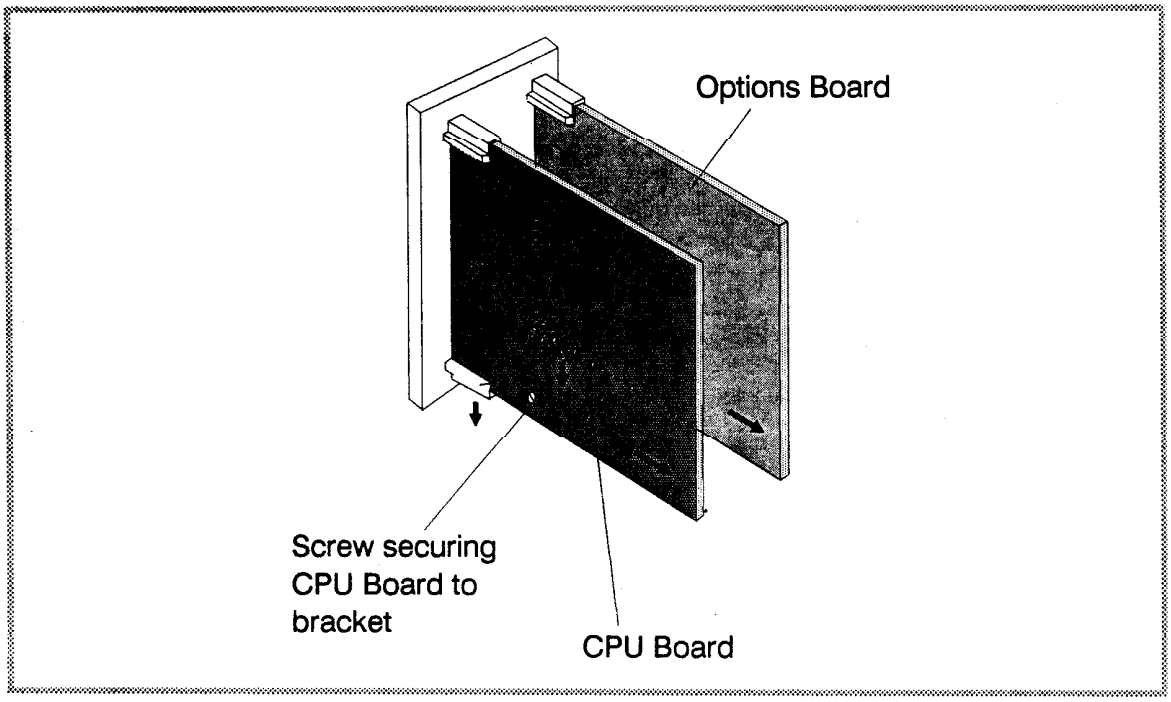



**Figure 6-1 Detaching the PCBs from the Front Panel**

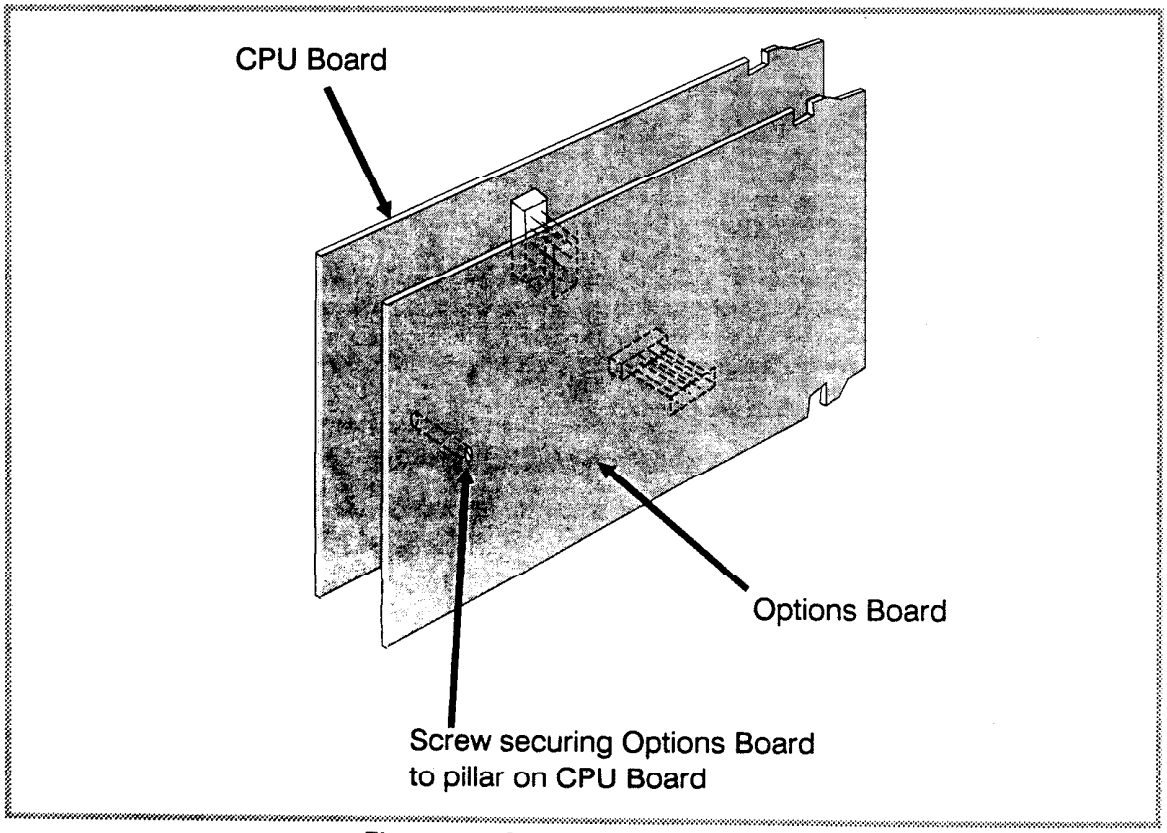



**Figure 6-2 Separating the Two PCBs**

## 6.2 CHANGING INPUT RANGES

### 6.2.1 Thermocouple Inputs

A Controller fitted with a thermocouple input may be re-configured to a different thermocouple input by changing jumper links on the CPU Board (see Figure 6-3) as shown in Table 6-1. Break protection link settings are shown in Table 6-2.

**Table 6-1 Thermocouple Input Link Jumpers**

| | Input | | CPU Board Link Jumpers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Product Code** | **Type** | **Range** | **LJ5** | **LJ6** | **LJ7** | **LJ8** | **LJ9** | **LJ17** | **LJ18** | **LJ19** |
| T1127 | R | 0 - 1650°C | P | X | P | X | X | X | - | X |
| T1128 | R | 32 - 3002°F | X | X | P | X | X | X | - | X |
| T1227 | S | 0 - 1650°C | P | P | X | P | P | X | - | X |
| T1228 | S | 32 - 3002°F | X | P | X | P | P | X | - | X |
| T1415 | J | 0 - 205°C | P | P | P | P | X | P | X | - |
| T1416 | J | 32 - 401°F | X | P | P | P | X | P | X | - |
| T1417 | J | 0 - 450°C | P | P | P | X | P | P | X | - |
| T1418 | J | 32 - 842°F | X | P | P | X | P | P | X | - |
| T1419 | J | 0 - 760°C | P | P | X | X | P | P | X | - |
| T1420 | J | 32 - 1400°F | X | P | X | X | P | P | X | - |
| T1541 | T | 0 - 260°C | P | X | X | X | P | X | - | X |
| T1542 | T | 32 - 500°F | X | X | X | X | P | X | - | X |
| T1719 | K | 0 - 760°C | P | P | P | X | X | P | X | - |
| T1720 | K | 32 - 1400°F | X | P | P | X | X | P | X | - |
| T1723 | K | 0 - 1731°C | P | X | P | P | P | P | X | - |
| T1724 | K | 32 - 2500°F | X | X | P | P | P | P | X | - |
| T1983 | B | 100 - 1820°C | P | P | X | P | X | X | - | X |
| T1984 | B | 212 - 3308°F | X | P | X | P | X | X | - | X |
| T4443* | Linear | 0 - 50mV | P | P | P | P | P | P | X | - |
| T4499* | Linear | 10 - 50mV | X | P | P | P | P | P | X | - |

X = Fitted P = Parked - = Not fitted

* A Controller with a thermocouple input can be changed to 0 - 50mV or 10 - 50mV linear input, but not to any other linear input range nor to RTD input.

**Table 6-2 Break Protection - Link Jumper Settings**

| | | Link Jumpers | |
|---|---|---|---|
| **Break Protection Type** | **Input Product Code** | **LJ14** | **LJ15** |
| Upscale | T---- | X | - |
| Downscale | T----21 | - | X |
| No protection | T----22 | P | - |

X = Fitted P = Parked - = Not fitted

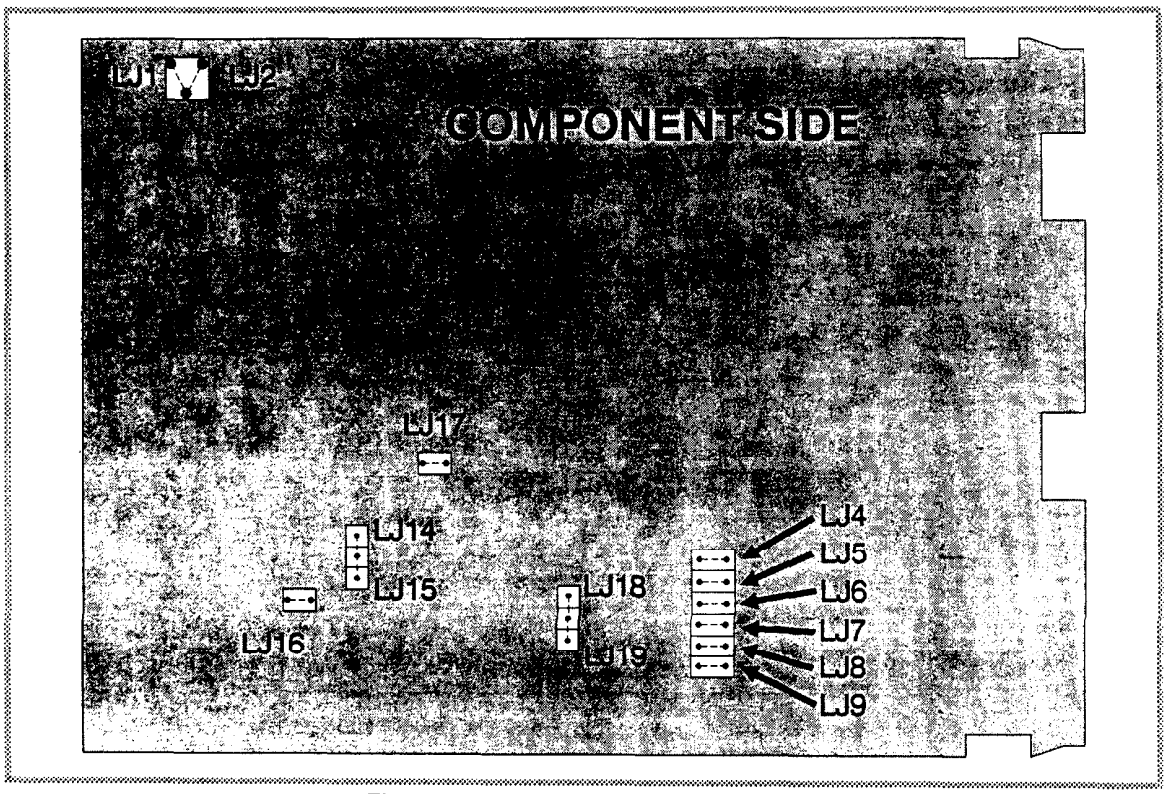



**Figure 6-3 CPU Board Link Jumpers**

## 6.2.2 RTD Inputs

A Controller equipped with an RTD Input may be re-configured to a different RTD Input by changing link jumpers on the CPU Board (see Figure 6-3) in accordance with the information in Table 6-3.

**Table 6-3 RTD Input Link Jumpers**

| Input | | CPU Board Link Jumpers | | | | | |
|---|---|---|---|---|---|---|---|
| **Product Code** | **Range** | **LJ5** | **LJ6** | **LJ7** | **LJ8** | **LJ9** | **LJ16** |
| T2221 | 0 to +600°C | P | X | X | P | X | P |
| T2222 | +32 to 1112°F | X | X | X | P | X | P |
| T2229 | +32 to +572°F | X | X | X | P | P | P |
| T2230 | -101.0 to +100.0°C | P | P | X | X | X | X |
| T2231 | -150.0 to +212.0°F | X | P | X | X | X | X |
| T2251 | 0 to +300°C | P | X | X | P | P | P |
| T2295 | 0.0 to +100.0°C | P | X | P | P | X | X |
| T2296 | +32.0 to +212.0°F | X | X | P | P | X | X |
| T2297 | -200 to +205°C | P | X | P | X | P | X |
| T2298 | -328 to +401°F | X | X | P | X | P | X |
| T7201 | -101.0 to +300.0°C | P | X | X | X | X | P |
| T7202 | -150 to +572°F | X | X | X | X | X | P |

X = Fitted P = Parked

### 6.2.3 Linear Inputs

In a Controller which has a Linear Input fitted, the CPU Board will have components which are specific to that linear input range; therefore, only limited re-ranging can be achieved by changing link jumper positions. Controllers with Product Code T4443 or T4499 may be changed from one to the other and vice versa; these Controllers may also be re-configured for thermocouple input, as described in Subsection 6.2.1. With any other linear input configurations, the only change possible by means of the link jumpers is alteration of the scale range minimum from 0% to 20% of scale range maximum and vice versa. Table 6-4 shows the Linear Input Product Codes which can be interchanged.

**Table 6-4 Linear Input Link Jumper Settings**

| Input Product Code | Input Range | Link Jumper LJ5 |
|---|---|---|
| T4412 | 0 - 100mV | Parked |
| T4416 | 20 - 100mV | Fitted |
| T4444 | 0 - 1V | Parked |
| T4415 | 0.2 - 1.0V | Fitted |
| T4445 | 0 - 5V | Parked |
| T4434 | 1 - 5V | Fitted |
| T3413 | 0 - 20mA | Parked |
| T3414 | 4 - 20mA | Fitted |

* Apart from Link Jumper LJ5, no other link jumpers should be altered.

## 6.3 CHANGING THE ACTION OF OUTPUT 1

Output 1 (Relay, SSR or DC output) may be configured to be direct-acting or reverse-acting:

**Reverse-Acting:** active (e.g. relay energised) when process variable < set point.

**Direct-Acting:** active (e.g. relay energised) when process variable > set point.

For a direct-acting Output 1 (Product Code H--31), link jumper LJ4 should be fitted on the CPU Board. For a reverse-acting Output 1 (the standard configuration), link jumper LJ4 on the CPU Board should be parked.

## 6.4 OUTPUT 2/EVENT OUTPUT AND ALARM OUTPUTS

### NOTE

The Output 2 and Event Output are mutually exclusive.

The Standard Options Board (Type 450), if fitted, provides Output 2/Event Output and/or an Alarm Output. This Options Board is supplied in one of five forms:

| Configuration | Product Code |
|---|---|
| Output 2/Event Output Relay, no Alarm Output | C10 or C0056 |
| Output 2 SSR, no Alarm Output | C50 |
| Output 2/Event Output Relay with Alarm Output | C10-- or C00--56 |
| Output 2 SSR with Alarm Output | C50-- |
| Alarm Output Only (no Output 2) | C00-- |

The action of Output 2 is always the opposite of that for Output 1 (i.e. if Output 1 is reverse-acting, Output 2 is direct-acting, or vice versa). If Output 2 or Event Output is to be used, link LJ20 on the Options Board (see Figure 6-4) should be fitted. If Output 2 or Event Output is not to be used, link LJ20 should be parked. To change the action of the Alarm Output, links on the Options Board should be fitted in accordance with the information in Table 6-5. Refer to Subsection 4.6 for details of Alarm Output operation.

**Table 6-5 Alarm Output Link Jumper Settings**

| Product Code | Link Jumpers LJ21 | LJ22 | LJ23 |
|---|---|---|---|
| C--50 | X | P | P |
| C--51 | X | P | X |
| C--46 | P | X | X |
| C--47 | P | X | P |
| C--48 | X | X | P |
| C--49 | X | X | X |
| C--00* | P | P | P |

* If Alarm Output is not supplied, link jumpers LJ21, LJ22 and LJ23 are omitted.

X = Fitted P = Parked

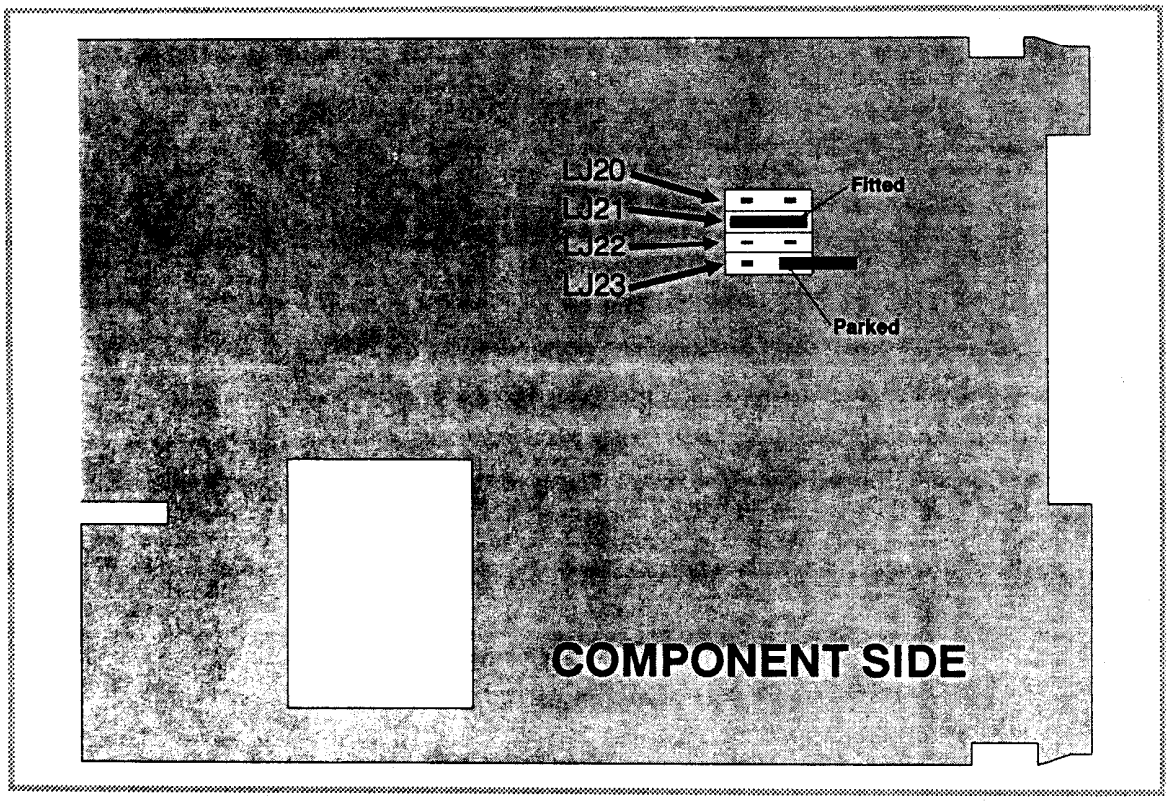



**Figure 6-4 Options Board 450 - Link Jumpers**

## 6.5 DC OUTPUTS (WITHOUT X06 OPTION)

The DC Output Options Board (Type 468) provides a DC output for Output 1 or Output 2 (but not both). This Board can be supplied with or without Alarm Output. When the Alarm Output is fitted, the Alarm Output functions are identical to those for the Standard Options Board (Type 450). The DC outputs are configured using link jumpers on the DC Output Options Board (see Figure 6-5 and Table 6-6). The required Alarm configuration is selected by link jumpers LJ21, LJ22 and LJ23 on the DC Output Options Board, as shown in Table 6-5.

DC output is selected for Output 1 or Output 2 using link jumpers on the DC Output Options Board (see Figure 6-5 and Table 6-6). The range of the DC Output can be changed by moving link jumpers on the Board as shown in Table 6-6. DC Output 1 is reverse-acting unless link LJ4 is fitted on the CPU Board (see Subsection 6.3); DC Output 2 is direct-acting unless link LJ4 is fitted on the CPU Board.

**Table 6-6 Options Board 468 - Link Jumper Settings**

| | Link Jumpers | | | | |
|---|---|---|---|---|---|
| **Product Code** | **LJ20** | **LJ24** | **LJ25** | **LJ26** | **LJ27** |
| H21 | * | P | P | X | X |
| H24 | * | X | P | X | X |
| H61 | * | P | X | X | X |
| H64 | * | X | X | X | X |
| C21 | X | P | P | P | X |
| C24 | X | X | P | P | X |
| C61 | X | P | X | P | X |
| C64 | X | X | X | P | X |

X = Fitted
P = Parked
* = Fit if Controller has Output 2 (C10 or C50) or Event Output (C0056 or C00--56) fitted.

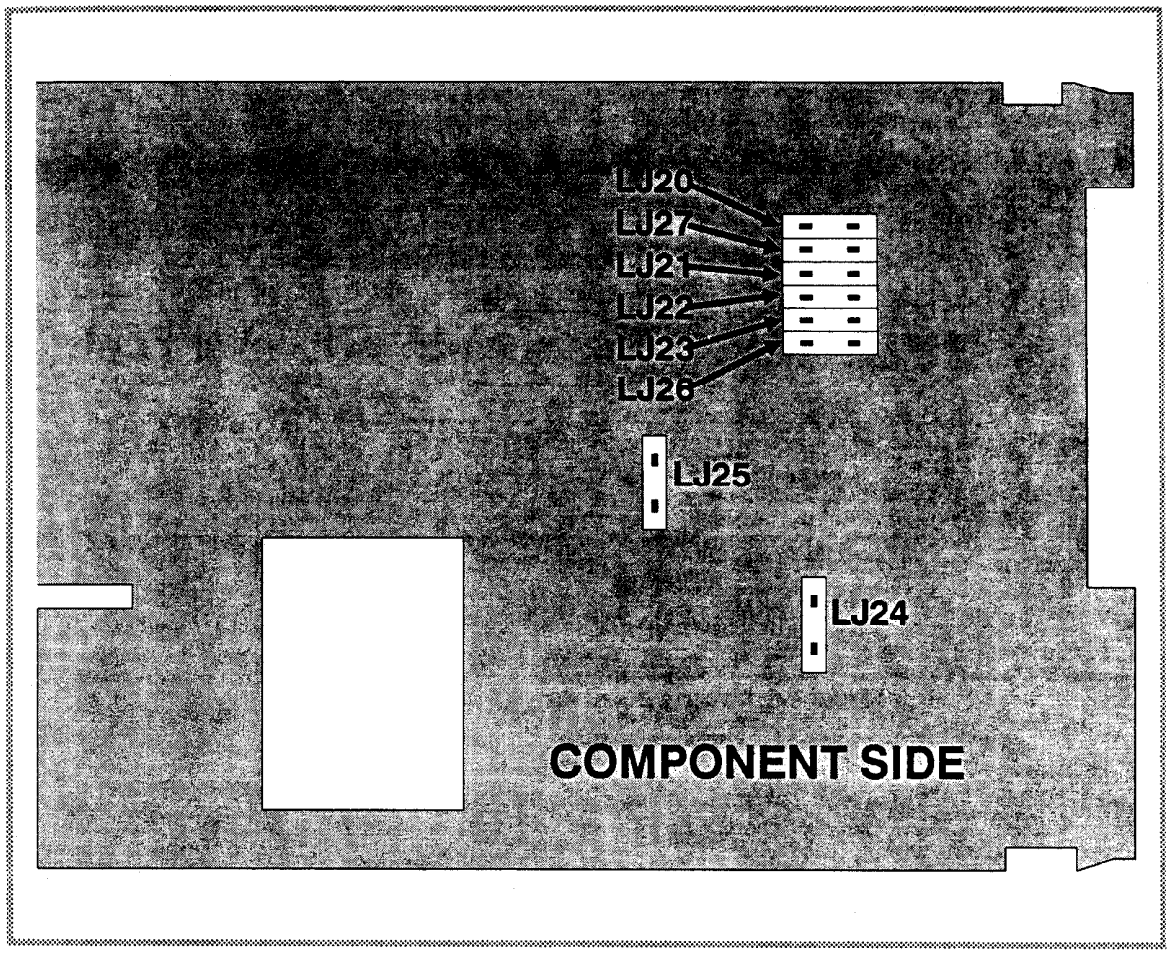



**Figure 6-5 Options Board 468 - Link Jumpers**

## 6.6 RS485 COMMUNICATIONS OPTIONS BOARD (TYPE 481)

This Options Board is supplied in one of four forms:

(1) Communications Option + Output 2/Event Relay: Codes C10 X06, C0056 X06

(2) Communications Option + Output 2 SSR: Code C50 X06

(3) Communications option + Alarm Output: Code C00-- X06

(4) Communications Option only: Code C00 X06

Figure 6-6 shows the switches and link jumpers on the RS485 Communications Options Board. When an option is not supplied, the associated link jumpers will not be fitted to the Board. If an Alarm Output is supplied, the operation of that Alarm Output is defined by the configuration of link jumpers LJ21, LJ22 and LJ23 (see Table 6-5 and the "C00--" entry in Table 6-7). If Output 2 is supplied, its action (direct or reverse) is the opposite of that for Output 1. The link jumper configurations to select Output 2 or Alarm Output are shown in Table 6-7. Switch functions are described in Section 5.

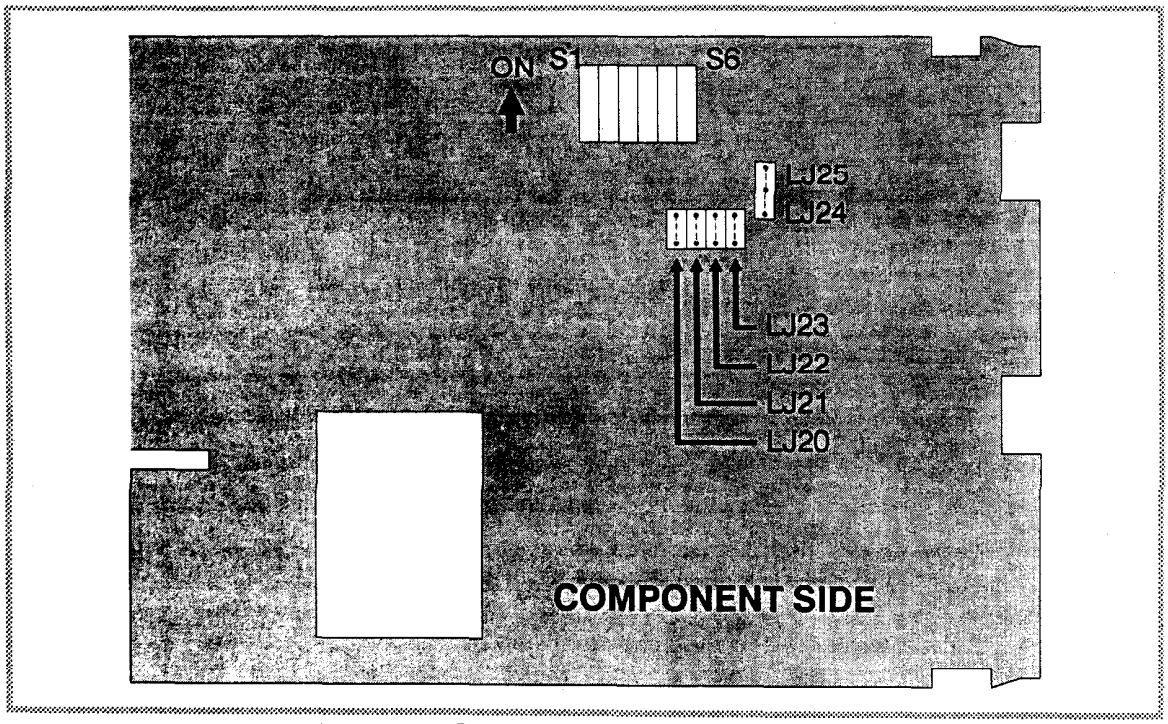



**Figure 6-6 Options Board 481 - Link Jumpers**

**Table 6-7 OP 2/Alarm Output - Link Jumper Settings**

| | Link Jumpers | | |
|---|---|---|---|
| **Product Code** | **LJ20** | **LJ24** | **LJ25** |
| C0000 | P | P | - |
| C1000 | X | X | - |
| C0056 or C00--56 | X | X | - |
| C5000 | X | X | - |
| C00-- | P | - | X |

## 6.7 DC OUTPUT/RS485 COMMUNICATIONS OPTIONS BOARD (TYPE 489)

This Options Board provides both an RS485-compatible communications link and a DC output for either Output 1 or Output 2 (but not both). The following combinations are available:

(1) DC Output 1 + Relay Event/Output 2 or SSR Output 2 + RS485 Communications
(2) Relay (or SSR) Output 1 + DC Output 2 + RS485 Communications
(3) DC Output 1 + Alarm (Relay) + RS485 Communications
(4) DC Output 1 + RS485 Communications

The selection of DC Output 1 or DC Output 2, the output ranges and the Alarm function are defined by means of link jumpers on this Options Board. Figure 6-7 shows the link jumper positions on the Type 489 Board and Tables 6-8 and 6-9 show the link jumper settings for the various configurations. Switch functions are described in Section 5.

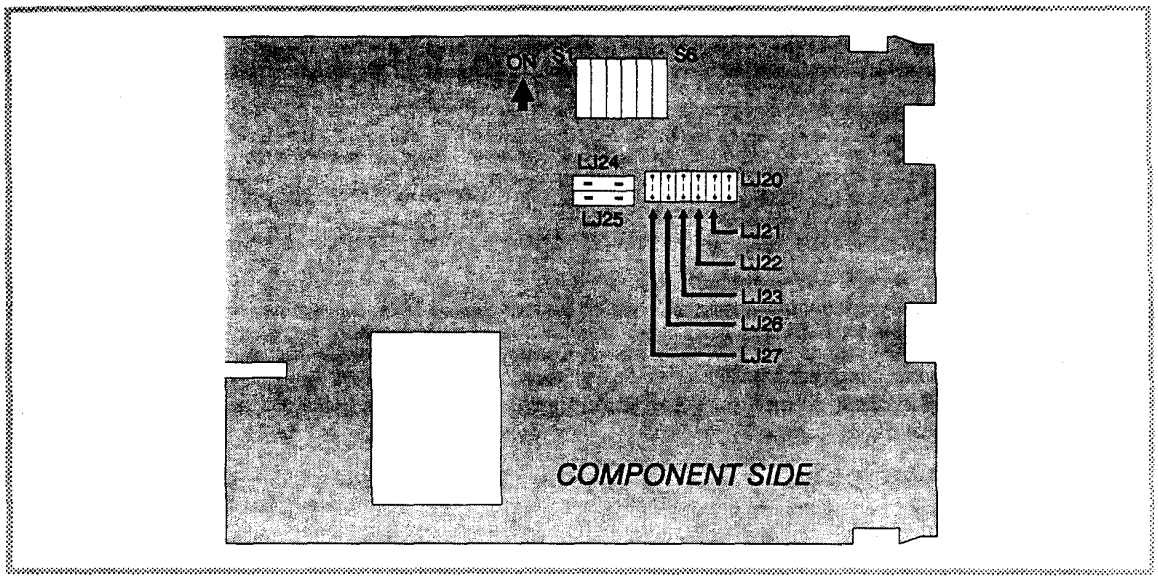



**Figure 6-7 Options Board 489 - Link Jumpers**

**Table 6-8 Options Board 489 - DC Output Jumpers**

| | Link Jumpers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Product Code** | **LJ20** | **LJ24** | **LJ25** | **LJ26** | **LJ27** | **LJ21** | **LJ22** | **LJ23** |
| H21 | * | P | P | ** | X | See Table 6-9 | | |
| H24 | * | X | P | ** | X | | | |
| H61 | * | P | X | ** | X | | | |
| H64 | * | X | X | ** | X | | | |
| C2100 | * | P | P | ** | X | P | P | P |
| C2400 | * | X | P | ** | X | P | P | P |
| C6100 | * | P | X | ** | X | P | P | P |
| C6400 | * | X | X | ** | X | P | P | P |

X = Fitted P = Parked

* Fit link LJ20 if Output 1 and Output 2/Event Output are required; otherwise park LJ20.

** Fit link LJ26 if Relay Output 2/Event Output (Code C10, C0056 or C00--56) or SSR Output 2 (Code C50) is required; otherwise park LJ26.

**Table 6-9 Option Board LJ Settings for CPU Board O/P**

| | Link Jumpers | | | |
|---|---|---|---|---|
| **Product Code** | ***LJ21*** | ***LJ22*** | ***LJ23*** | |
| H10 | P | P | P | Output type (Relay or SSR) is determined by components fitted on the CPU Board. |
| H50 | P | P | P | |
| C1000 | P | P | P | |
| C5000 | P | P | P | |
| C0000 | P | P | P | Output on the CPU Board not used. |
| C0050 | X | P | P | Standard Alarm Output requires the use of a CPU Board with Relay output. |
| C0051 | X | P | X | |
| C0046 | P | X | X | |
| C0047 | P | X | P | |
| C0048 | X | X | P | |
| C0049 | X | X | X | |
| C0056 or C00--56 | P | P | P | *Requires the use of a CPU Board* with Relay output. |

X = Fitted P = Parked

## 6.8 OPTIONS BOARD 496

This Options Board provides the controller with Recorder Output and Relay/SSR Output. *The RS485 Communications Link Option is not available when this Options Board is fitted.* The following combinations are available (in addition to the process input and Output 1):

(1) Alarm or Output 2 Relay or Event Output Relay + Recorder Output

(2) SSR Output 2 + Recorder Output

(3) Recorder Output only

(4) VMD Output + Recorder Output

The selection of Output 2 type or Event Output, the Alarm relay and the Recorder Output option is defined by link jumpers on the Options Board. The locations of the link jumpers are shown in Figure 6-8 and the available link jumper settings are shown in Table 6-10.

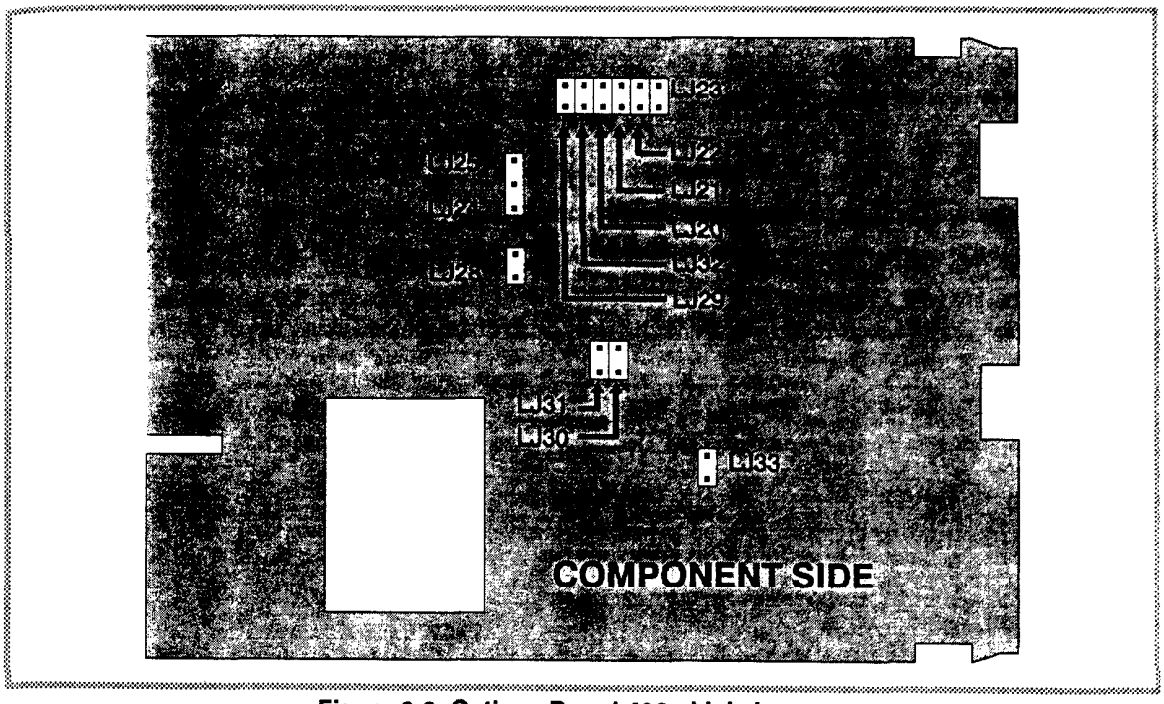



**Figure 6-8 Options Board 496 - Link Jumpers**

**Table 6-10 Options Board 496 - Link Jumper Settings**

| | Link Jumpers | | | | | |
|---|---|---|---|---|---|---|
| **Product Code** | **LJ20** | **LJ21** | **LJ22** | **LJ23** | **LJ24** | **LJ25** |
| C00 | P | P | P | P | - | X |
| C10, C0056 or C00--56 | X | P | P | P | X | - |
| C50 | X | P | P | P | X | - |
| C0046 | P | P | X | X | - | X |
| C0047 | P | P | X | P | - | X |
| C0048 | P | X | X | P | - | X |
| C0049 | P | X | X | X | - | X |
| C0050 | P | X | P | P | - | X |
| C0051 | P | X | P | X | - | X |
| H70C0000* | P | P | P | P | X | - |

* Special software required.

Link jumpers LJ28, LJ29, LJ30 and LJ31 must be parked.

| Product Code | LJ32 | LJ33 |
|---|---|---|
| X12 | P | X |
| X18 | P | P |
| X19 | X | P |
| X20 | X | X |
| Recorder O/P OFF | P | P |

P = Parked X = Fitted - = Not fitted

## 6.9 OPTIONS BOARD 497

This Options Board provides the controller with Recorder Output and DC Output. *The RS485 Communications Link Option is not available when this Options Board is fitted.* The following combinations are available (in addition to process input):

(1) DC Output 1 + Relay/SSR Output 2 or Event Output Relay + Recorder Output

(2) DC Output 1 + Alarm + Recorder Output

(3) Relay/SSR Output 1 + DC Output 2 + Recorder Output

The selection of output type, alarm type and the Recorder Output option is defined by link jumpers on the Options Board. The locations of the link jumpers are shown in Figure 6-9 and the available link jumper settings are shown in Table 6-11.

**Table 6-11 Options Board 497 - DC Output Link Jumpers**

| | Link Jumpers | | | | | | |
|---|---|---|---|---|---|---|---|
| **Product Code** | **LJ20** | **LJ24** | **LJ25** | **LJ26** | **LJ21** | **LJ22** | **LJ23** |
| H21 | * | P | P | ** | See Table 6-12 | | |
| H24 | * | X | P | ** | | | |
| H61 | * | P | X | ** | | | |
| H64 | * | X | X | ** | | | |
| C2100 | * | P | P | ** | P | P | P |
| C2400 | * | X | P | ** | P | P | P |
| C6100 | * | P | X | ** | P | P | P |
| C6400 | | X | X | ** | P | P | P |

X = Fitted P = Parked

* Fit Link LJ20 if Output 1 and Output 2/Event Output are required; otherwise park.

** Fit Link LJ26 if Relay Output 2/Event Output (Code C10, C0056 or C00--56) or SSR Output 2 (Code C50) is required; otherwise park.

**Table 6-12 Option Board 497 - LJs for CPU Board O/P**

| | Link Jumpers | | | |
|---|---|---|---|---|
| **Product Code** | **LJ21** | **LJ22** | **LJ23** | |
| H10 | P | P | P | Output type (Relay or SSR) is determined by components fitted on the CPU Board. |
| H50 | P | P | P | |
| C1000 | P | P | P | |
| C5000 | P | P | P | |
| C0000 | P | P | P | Output on the CPU Board not used. |
| C0050 | X | P | P | Standard Alarm Output requires the use of a CPU Board with Relay output. |
| C0051 | X | P | X | |
| C0046 | P | X | X | |
| C0047 | P | X | P | |
| C0048 | X | X | P | |
| C0049 | X | X | X | |
| C0056 or C00--56 | P | P | P | Requires the use of a CPU Board with Relay output. |

X = Fitted P = Parked

**Table 6-13 Options Board 497 - Option Selection Link Jumpers**

Link jumpers LJ28, LJ29, LJ30 and LJ31 must be parked.

P = Parked
X = Fitted

| Product Code | LJ32 | LJ33 |
|---|---|---|
| X12 | P | X |
| X18 | P | P |
| X19 | X | P |
| X20 | X | X |
| Recorder O/P OFF | P | P |

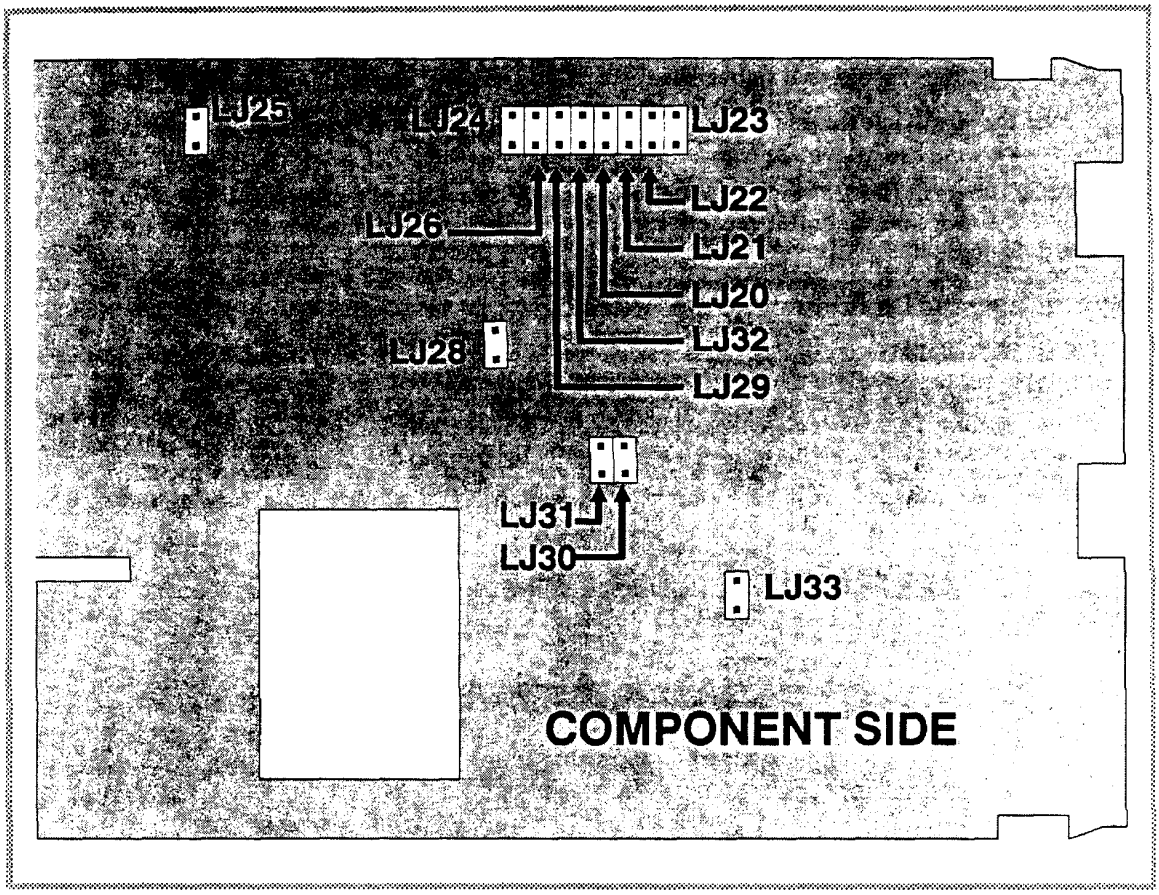



**Figure 6-9 Options Board 497 - Link Jumpers**

## 6.10 CHANGING THE MAINS (LINE) SUPPLY VOLTAGE

On the CPU Board, link jumper LJ1 is fitted for operation on a 193V - 264V supply (Code L01) and link jumper LJ2 is fitted for operation on a 100V - 132V supply (Code L02). It is not possible to re-configure the Controller to/from 24V operation (Code L04).

## 6.11 ASSEMBLING THE CONTROLLER

### 6.11.1 Fitting the Options Board to the CPU Board (if required)

1. Hold the two boards side-by-side with the component sides facing each other and the PC connectors aligned.

2. Carefully align the multiple-pin plugs on the Options Board with the sockets on the CPU Board and gently engage the plugs and sockets.

3. Insert the screw (made available during the previous separation of the two boards) through the hole in the Options Board into the pillar on the CPU Board and tighten until both boards are secured together.

### 6.11.2 Fitting the Boards to the Front Panel Assembly

1. Align the boards with the guides attached to the front panel; the CPU Board (the one with a transformer) should be on the right-hand side when viewed from the front. Ensure that the plugs on the CPU Board are aligned with the sockets on the front panel assembly.

2. Push the boards into the guides until all the teeth on the boards locate firmly into the holes in the guides.

3. Insert the screw (made available during the previous dismantling of the Controller) through the CPU Board into the bracket attached to the front panel; tighten the screw to secure the boards in position.

### 6.11.3 Fitting the Controller into the Housing

1. Carefully slide the Controller, rear end first, into the housing, ensuring that the circuit board(s) locate against the outside of the guides moulded into the top and bottom of the housing.

2. Push the Controller firmly into position in order that the rear connectors of the circuit board(s) make good connection with the terminals at the rear of the housing.

3. Engage the locking screw (at the bottom of the front panel) in its bush in the housing and tighten until the Controller is secured in its housing.

# APPENDIX A
# SPECIFICATION FOR 3750 PROGRAMMER/CONTROLLER

## INPUT

| | |
|---|---|
| Input Types: | Thermocouple, Resistance Temperature Detector (RTD) and DC Linear. |
| Common Mode Rejection: | Negligible effect up to 264V 50/60Hz. |
| Series Mode Rejection: | 1000% of span (at 50/60Hz) causes negligible effect. |
| Thermocouple Break Protection: | Upscale (standard), downscale (optional) or none (optional). |
| Thermocouple Calibration: | Complies with BS4937, NBS125 and IEC584 standards. |
| RTD (Pt100) Calibration: | Complies with BS1904 and DIN43760 standards. |

## OUTPUTS

### Output 1

| | |
|---|---|
| Relay: | SPDT, contact rating 5A resistive @ 120V/240V AC. Relay life $10^6$ operations. |
| Solid State Relay (SSR) Drive: | 0V - 12V nominal, 18V maximum. Output impedance 250Ω. |

### Output 2 or Event Output (Optional)

| | |
|---|---|
| Relay: | SPDT, contact rating 2A resistive @ 120V/240V AC. Relay life $10^6$ operations. |
| Solid State Relay (SSR) Drive: | 0V - 12V nominal, 18V maximum. Output impedance 250Ω. |

### DC Output (Optional)

The DC Output option may be fitted either on Output 1 or on Output 2, but not both. The output is normally isolated to withstand up to 260V (it is non-isolated if the RS485 Communications Option - Option X06 - is fitted). The are four variants of the DC Output option:

1. 4mA - 20mA nominal into 500Ω maximum
2. 0mA - 20mA nominal into 500Ω maximum
3. 1V - 5V nominal into 50kΩ minimum
4. 0V - 5V nominal into 50kΩ minimum

### Recorder Output (optional)

| | |
|---|---|
| Output Range: | 4 - 20mA or 0 - 20mA into 500 ohms maximum. |
| | 1 - 5V or 0 - 5V; output impedance = 250 ohms |
| Resolution: | > 10 bits |
| Accuracy: | ±0.5% of span |
| Temperature Stability: | ±0.025%/°C |

**Alarm Output (Optional)**

Alternative configurations:

| Alarm Type | Relay Energised | ALM LED Flashes |
|---|---|---|
| Process High Alarm (Fail-safe) | PV below alarm value | PV above alarm value |
| Process High Alarm | PV above alarm value | PV above alarm value |
| Band Alarm | PV within deviation band | PV outside deviation band |
| +ve deviation direct-acting | PV > (SP + deviation) | PV > (SP + deviation) |
| -ve deviation direct-acting | PV < (SP - deviation) | PV < (SP - deviation) |
| +ve deviation reverse-acting | PV < (SP + deviation) | PV > (SP + deviation) |
| -ve deviation reverse-acting | PV > (SP - deviation) | PV < (SP - deviation) |

Relay: SPDT, contact rating 2A resistive @ 120V/240V AC. Relay life $10^6$ operations.

**RS485 COMMUNICATIONS LINK**

Three-wire transmit/receive connections, driven from an isolated power supply. Transceiver conforms to EIA Standard RS485.

**CONTROL**

Proportional Band: 0% - 1000% of span. (1% - 1000% of span with VMD Open Loop Option fitted).

Cycle Time

- Output 1: 1/2, 1, 2, 4, 8, 16, 32 or 64 seconds.
- Output 2: 1/2, 1, 2, 4, 8, 16, 32, 64, 128, 256 or 512 seconds.

Relative Gain: 0.02 to 1 and ON/OFF (>1.00)

Overlap/Deadband: -20% to +20% of Proportional Band.

Integral Time Constant: 10 seconds - 30 minutes (in one-second increments) and OFF. (10 seconds - 99 minutes 59 seconds with VMD Open Loop Output Option - no OFF setting for this configuration.)

Derivative Time Constant: 00 seconds - 10 minutes in one-second increments.

ON/OFF Differential: 0.1% - 10% of span.

**ENVIRONMENT**

Reference Conditions

- Ambient Temperature: 20°C ±2°C
- Supply Voltage: 120V or 240V ±1% 50/60Hz ±1%
- Thermocouple source resistance: <10Ω
- RTD (Pt100): <0.1Ω per lead, both leads equal.
- Relative Humidity: 60% - 70%

Operating Conditions

- Ambient Temperature: 0°C - +50°C (operating)
  -20°C - +60°C (storage)
- Supply Voltage: 193V - 264V @ 50/60Hz
  100V - 132V @ 50/60Hz
- Maximum Source Resistance
  - Thermocouple: < 1000Ω
  - RTD (Pt100): < 5Ω per lead (equal resistance in each lead).

**PERFORMANCE**

Reference Accuracy: Typically, ±0.5% of span, ±1 lsd.

Temperature Stability: < 0.015% of span for 1°C change in ambient temperature.

Cold Junction Compensation: < 0.1°C change for 1°C change in ambient temperature.

Effect of Thermocouple Resistance: < 0.1% of span error for resistance 0Ω - 100Ω.

Effect of RTD Lead Resistance: < 0.1% of span error for 3Ω lead resistance.

Effect of Supply Voltage Change: < ±0.1% of span error for supply voltage within specified limits.

**GENERAL**

Display: Light-emitting diode (LED) display showing:

* Four-digit seven-segment numeric display
* A wide range of function/parameter legends

Front Panel Controls: Four pushbuttons:

Run-Time Select

Function Select

Raise

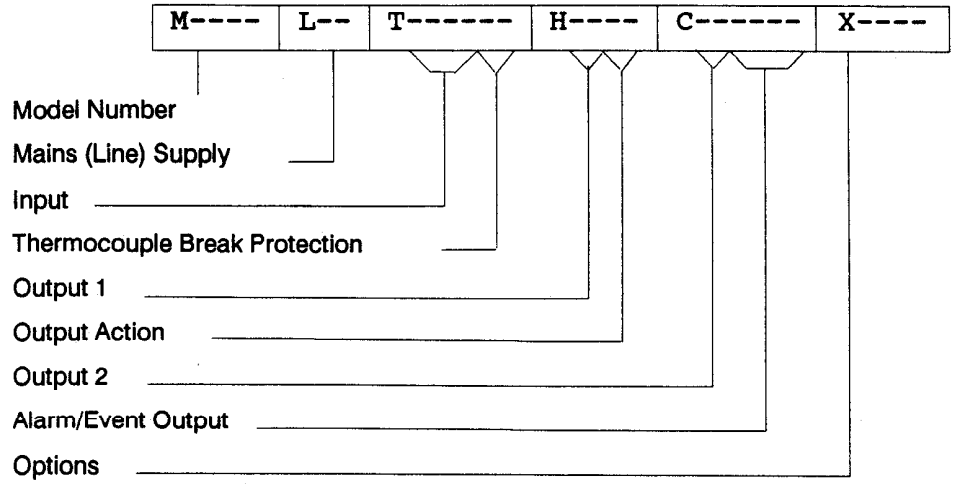
Lower

Dimensions

- Width: 48mm (1.89 in.)
- Height: 96mm (3.78 in.)
- Depth: 153mm (6.02 in.)
- Weight: 0.6kg (1.32 lb)

Power Consumption: Approximately 5VA.

# APPENDIX B
# PRODUCT CODES




**MODEL NUMBER**

M3750

**MAINS (LINE) VOLTAGE**

| | |
|---|---|
| L01 | 200V/240V nominal @ 50/60Hz |
| L02 | 110V/120V nominal @ 50/60Hz |
| L04 | 24V nominal @ 50/60Hz |

**INPUT - TYPE AND RANGE**

**Thermocouple**

| | | | | | |
|---|---|---|---|---|---|
| T1127 | R | 0 - 1650°C | T1420 | J | 32 - 1400°F |
| T1128 | R | 32 - 3002°F | T1541 | T | 0 - 260°C |
| T1227 | S | 0 - 1650°C | T1542 | T | 32 - 500°F |
| T1228 | S | 32 - 3002°F | T1719 | K | 0 - 760°C |
| T1415 | J | 0 - 205°C | T1720 | K | 32 - 1400°F |
| T1416 | J | 32 - 401°F | T1723 | K | 0 - 1371°C |
| T1417 | J | 0 - 450°C | T1724 | K | 32 - 2500°F |
| T1418 | J | 32 - 842°F | T1983 | B | 100 - 1820°C |
| T1419 | J | 0 - 760°C | T1984 | B | 212 - 3308°F |

**Thermocouple Break Protection**

| | |
|---|---|
| T---- | Upscale break protection (standard) |
| T----21 | Downscale break protection |
| T----22 | No break protection |

**Three-wire Resistance Temperature Detector (RTD)**

| | | | |
|---|---|---|---|
| T2221 | 0 to +600°C | T2295 | 0.0 to +100.0°C |
| T2222 | +32 to +1112°F | T2296 | +32.0 to +212.0°F |
| T2229 | +32 to +572°C | T2297 | -200 to +205°C |
| T2230 | -101.0 to +100.0°C | T2298 | -328 to +401°F |
| T2231 | -150.0 to +212.0°F | T7201 | -101.0 to +300.0°C |
| T2251 | 0 to +300°C | T7202 | -150 to +572°F |

**DC Linear Input**

| | | | |
|---|---|---|---|
| T4443 | 0 - 50mV | T4415 | 0.2 - 1.0V |
| T4499 | 10 - 50mV | T4445 | 0 - 5V |
| T4412 | 0 - 100mV | T4434 | 1 - 5V |
| T4416 | 20 - 100mV | T3413 | 0 - 20mA |
| T4444 | 0 - 1V | T3414 | 4 - 20mA |

**OUTPUTS**

Output 1 (Normally reverse-acting)

| | | | |
|---|---|---|---|
| H10 | Relay | H61* | DC Output 1V - 5V |
| H50 | SSR Drive | H64* | DC Output 0V - 5V |
| H21* | DC Output 4mA - 20mA | H70** | VMD Open Loop Output |
| H24* | DC Output 0mA - 4mA | | |

* DC Output 2 is not available with DC Output 1.

** VMD Open Loop Output is available with the following restrictions:

(a) Output 2 is not available if the VMD Open Loop Output is fitted.

(b) The VMD Open Loop Output cannot be re-configured to any other output option; Controllers with any other output cannot be re-configured to VMD Open Loop Output.

Output 1 Option:

| | |
|---|---|
| H--31 | Direct-Acting |

**Output 2 (Action opposite to Output 1 i.e. normally direct-acting) or Event Output**

| | |
|---|---|
| C00 | Output 2 not fitted |
| C10 | Relay |
| C50 | SSR Drive |
| C21* | DC Output 4mA - 20mA |
| C24* | DC Output 0mA - 20mA |
| C61* | DC Output 1V - 5V |
| C64* | DC Output 0V - 5V |
| C0056 or C00--56** | Event Output (C00--56 = Event Output with alarm) |

* DC Output 2 is not available with DC Output 1.

** Event Output and Output 2 are mutually exclusive.

**Alarms**

| | |
|---|---|
| C--50 | Relay, high/low deviation (direct-acting) |
| C--51 | Relay, high/low deviation (reverse-acting) |
| C--46 | Band Alarm, relay ON if process variable inside band |
| C--47 | Band Alarm, relay ON if process variable outside band |
| C--48 | Relay, process alarm (direct-acting) |
| C--49 | Relay, process alarm (reverse-acting) |

**OTHER OPTIONS**

| | |
|---|---|
| X06 | RS485-compatible communications link (with Option X06 fitted, it is possible to have Output 2, Event Output or Alarm Output fitted, but not more than one of these). |

## NOTE

The Communications Option is not available with Recorder Output

| | |
|---|---|
| X69 | Push-on blade terminals |
| X73 | 1/4 DIN to 1/8 DIN conversion plate. |
| X79 | Remote Front Panel with 0.5m connecting cable |
| X74 | Remote Front Panel with 2.0m connecting cable |
| X75 | Remote Front Panel with 5.0m connecting cable |
| X76 | Chassis Mounting Bracket for use with X74, X75 or X79 |
| X12 | Recorder Output 0 - 5V |
| X18 | Recorder Output 0 - 20mA |
| X19 | Recorder Output 4 - 20mA |
| X20 | Recorder Output 1 - 5V |